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DESIGN OF AN AUTOMATIC PASSENGER COUNTING/TRACKING SYSTEM FOR AIRPORTS

FINAL REPORT

Prepared for:

TRANSPORTATION DEVELOPMENT CENTRE,
POLICY AND COORDINATION GROUP,
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By

PIERRE CHÉNIER
MICHEL BARRÉ

DTI TÉLÉCOM INC.

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DTI Télécom
[illegible]
Montréal (Québec)
H3A 1V4
(514) 845-3225
Télex: 05-845841
Fax: (514) 845-4[illegible]

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PIERRE CHÉNIER

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Montréal (Québec)
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16. Abstract

Purpose: Development of an automatic passenger counting/tracking system suitable for implementation in any Canadian airport.

Methodology: Visits of four typical airports: Dorval (Montreal), Toronto (terminals 1 and 2), Thunder Bay and Ste-Foy (Quebec); in order to get a comprehensive view of airport environments and to perform an analysis of the relevant operational problems.

A technology study to determine the best suited detection technologies and associated devices as well as the appropriate data processing equipment.

Results: Basic concepts are developed about people flows in airports. A generic design for detection/counting system is brought forward and validated with an analytical approach. Finally, a demonstration project is proposed, with Dorval as a target airport.

Conclusions: This document completes the design phase of the project and can be used as a guideline for the implementation and testing of a prototype counting/tracking system at Dorval or at any other Canadian airports.

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16. Résumé

But: Conception d'un système de comptage automatique des passagers, pouvant être installé dans tout aéroport canadien.

Méthodologie: Visites de quatre aéroports typiques: Dorval (Montréal), Toronto (terminaux 1 et 2), Thunder Bay et Ste-Foy (Québec); pour comprendre le contexte aéroportuaire et en saisir les contraintes opérationnelles.

Une étude technologique visant à déterminer le mode de détection le plus approprié, les dispositifs correspondants ainsi que les appareils requis pour en traiter les signaux.

Résultats: Des concepts sont émis concernant la circulation des gens dans les aéroports. Un système de détection/comptage est conçu de façon générique et consolidé par une approche analytique. Enfin, on y propose l'établissement d'un tel système à Dorval en tant qu'aéroport-cible.

Conclusion: Ce document clôt la phase I du projet en servant de guide à la phase II, soit: établir un système prototype de comptage, particulièrement à Dorval, ou dans tout autre aéroport canadien sur la base d'une étude de cas spécifique.

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SUMMARY

The present report describes a detection/counting system designed to provide Canadian airports with statistical data on a day-to-day basis about enplaning and deplaning passengers, their escorts (called "meeters and greeters") and visitors. Four airports (Dorval, Thunder Bay, Toronto terminal 1 and terminal 2 and Ste-Foy) were visited to acquire knowledge of airport operational environments. Relevant constraints and requirements were documented prior to system design.

Three levels of counting were defined:

First level: All enplaning/deplaning passengers, by domestic, international and transborder sectors.

Second level: Previous level plus the general public including meeters/greeters and visitors.

Third level: The two previous levels plus specific data relative to operational and marketing facilities in the airport.

The second level is considered the "minimum capabilities" level, meeting the requirements of the Airports Authority Group of Transport Canada; the system design complies with this level of counting.

Due to the variety of airports involved, a generic design approach, validated by an analytical study, was used to cover the following:

1° Characterization of two categories of detection area: threshold and open space.

2° Establishment of a four-subsystem architecture: sensing, link, signal conditioning and central station.

It was found that no off-the-shelf system exists for this particular application. Most of the devices and equipment that could be used for detection and data processing are primarily designed for security, door opening, access card control or industrial control. A technology review was therefore conducted. For the threshold category, active infra-red technology was found to be best suited and was applied in two basic configurations:

1° Horizontal retro-reflective beams.

2° Overhead diffuse reflective beams, including a logic table associated with multiple beam threshold to interpret counts.

For open-space category, active infra-red and other technologies such as weight sensitivity, ultra-sound and video analysis are proposed, depending on specific detection area requirements.

A three step research project to implement and test a prototype system at Dorval airport is proposed:

1° Test project

- First step covering all passengers (level 1): $ 75 000
- Second step adding eight general public doors: $ 25 000

2° Pilot project

- Third step covering all passengers and general public (level 2): $ 300 000

Cost estimates include equipment, installation and project management costs.

SOMMAIRE

Le présent rapport décrit un système de détection/comptage pouvant être installé dans tout aéroport canadien afin d'obtenir quotidiennement des données statistiques sur les passagers partant et arrivant, sur leurs escortes et les visiteurs. Quatre aéroports typiques (Dorval, Thunder Bay, Toronto (terminaux 1 et 2) et Ste-Foy) ont été visités afin de comprendre le contexte aéroportuaire d'un point de vue opérationnel. Les contraintes et exigences pertinentes relevées ont servi de guide pour la conception du système.

Trois niveaux de comptage ont été identifiés:

Premier niveau: tous les passagers partant et arrivant, par secteur intérieur, international ou transfrontalier;

Deuxième niveau: le niveau précédent, plus le public général comprenant les escortes et les visiteurs;

Troisième niveau: les deux niveaux précédents, plus toutes études particulières relatives aux facilités opérationnelles et commerciales de l'aéroport.

Le deuxième niveau est considéré comme celui des "capacités minimales", conformément aux exigences du Groupe de gestion des aéroports. Le système de détection/comptage est conçu en fonction de ce niveau.

En raison de la variété des aéroports impliqués, une approche générique, consolidée d'un concept analytique adapté, ont été utilisés pour couvrir:

1° La caractérisation des zones de détection en deux catégories: seuil et aire ouverte.

2° La mise sur pied d'une architecture à quatre sous-systèmes: détection, lien, conditionnement du signal et station centrale.

Les recherches ont démontré qu'aucun système intégral n'existait pour cette application particulière. De plus, la plupart des dispositifs et appareils envisagés pour la détection et le traitement des données sont conçus essentiellement pour les domaines de la sécurité, de commande de portes, de contrôle par cartes d'accès ou de contrôle industriel. Une étude technologique a donc été entreprise; pour la catégorie seuil, la technologie de l'infrarouge actif s'est révélée la plus appropriée et a été retenue selon deux configurations de base:

1° Faisceau horizontal rétroréfléchi.

2° Faisceau vertical capté en diffusion, comprenant une table logique susceptible d'interpréter les comptes d'un seuil à faisceaux multiples.

Pour la catégorie aire ouverte, les technologies de l'infrarouge actif, de la sensibilité gravitationnelle, des ultra-sons et de l'analyse vidéo sont suggérées selon les contextes particuliers des zones de détection concernées.

Une étude d'implantation est esquissée pour l'aéroport de Dorval sur une base progressive selon trois étapes:

1° Projet test

- Première étape, couvrant tous les passagers (niveau 1): 75 000 $
- Deuxième étape, ajoutant huit portes publiques: 25 000 $

2° Projet pilote

- Troisième étape, couvrant tous les passagers ainsi que le public général (niveau 2): 300 000 $

Ces coûts comprennent l'équipement, l'installation et la gestion du projet.

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APPENDICES

A: Considerations with respect to using count processing to establish the profile of target users

B: Indication of people flows (visual aids) related to general public, departures and arrivals:

- Dorval (two floor plans)
- Thunder-Bay (one floor plan)
- Ste-Foy (two floor plans)

C: Test/pilot project for Dorval airport:

- Counting system, test and pilot project configuration
- Preliminary list of equipment
- Documentation on equipment

1. INTRODUCTION

1.1 Background

The existing system for collecting statistics on passenger activity at Canadian airports no longer satisfies new operational management and market research needs of airports. Technology may provide an acceptable supplement or alternative to these sources. With technology, the Airports Authority Group (AAG) of Transport Canada will attempt to reduce the unit of time increment for which the information is available (by month, week or day), reduce the time between the availability of the information and the period in which the information was collected (within a month, week or day) and as a bonus, to quantify non-passenger people activity at the airports (meeters, greeters and visitors).

Currently, there are two sources of passenger activity statistics. The first and the only officially sanctioned source of such statistics is Statistics Canada. It has the legal authority to collect traffic statistics and an array of financial statements from each air carrier. However, the rigourous and complex reporting mechanisms by which data is collected can only produce total passenger statistics by sector with a yearly breakdown, and this information can only be made available f om 9 to 12 months after year end. Changes to this source would be impractical. The second source is the ad-hoc collection of passenger activity statistics directly from the airline station managers by the individual airport managers. This information is available on a monthly basis and, more importantly, within one month after the activity has occurred. The drawback with these statistics is that they are not always consistent or accurate.

There is no system in place to quantify the non-passenger users of terminal buildings. Meeter or greeter per passenger ratios are compiled during periodic consumer surveys but are not updated regularly.

The current system is acceptable for long-range planning and development but cannot respond to the short-term needs of airports in quest of financial self-sufficiency and increased profitability.

1.2 Terms of reference

The present study was carried out by DTI Telecom Inc. at the request of the **Transportation Development Centre (TDC)** of the Policy and Coordination Group of Transport Canada **on behalf of the AAG.** The overall objective is to provide terminal user counts on either a continuous or periodic basis at various sectors of an air terminal building.

TDC gave DTI Telecom Inc. (DTI) the mandate to perform task #6-JR, contract no. T8200-6-6509/01-AF, as referred to in the work statement: Development of an Automatic Passenger Counting/Tracking System, Appendix "A", February 26, 1988.

The present report completes phase I of this project in providing concepts, the analytical approach and a description of typical equipment. It describes the elements essential to phase II of the project: an airport user detection/counting system of a prototype level, suitable for implementation at any Canadian airport.

1.3 Methodology

In order to meet the objective of this study, it was necessary to:

1. Conduct background research to examine:

   - the types of passenger information that can be gathered automatically;

   - automatic passenger counting technology of all levels of sophistication;

   - international experience in passenger counting and person-counting in airport transit, traffic and entertainment applications.

2. Carry out a survey of Air Terminal Building operations at the following Canadian airports:

   - Montreal International Airport (Dorval);
   - Thunder Bay, Ontario;
   - Lester B. Pearson, Terminal 1 and Terminal 2 (Toronto);
   - Sainte-Foy, Québec.

3. Perform an analysis of operational problems in obtaining reasonable and reliable passenger counts.

4. Document the functional specifications of a passenger counting/tracking system.

5. Design a feasible detection/counting system suitable for statistical tracking on a generic basis for implementation at any Canadian Airport (present report).

2. FUNCTIONAL SYSTEM REQUIREMENTS

2.1 Constraints and limitations

2.1.1 Related to airport environment

The proposed detection/counting system must take into account the airport environment, a public building with peculiar security considerations.Therefore, detectors, cabling and accessories should:

1° not interfere with the circulation of people;
2° be visually discreet;
3° be robust for reliability and minimum maintenance;
4° minimize modifications to the existing environment;
5° preserve security facilities;
6° must not interrupt nor interfere with existing and future services/facilities of the airport, such as:

- telephone system;
- security system;
- emergency lighting;
- radio system;
- existing equipments;
- etc.

2.1.2 Related to people circulating in the airport

The detection/counting system is to be designed and implemented to count people circulating in the airport. Therefore, the following requirements have to be considered:

1° The system must be suitable for counting purposes. This requires that the detection fields be well defined and the associated detection devices have proper responsiveness.

2° The detection fields must be totally harmless to detected persons, including those who suffer from particular health conditions.

3° The persons to be detected and counted are varied in their behaviour as well as their appearance, e.g.:

- some have luggage, others don't;
- some walk fast, others walk slowly;
- sometimes there may be a space between them; at other times, they may walk close to each other;
- shape and height is quite varied;
- clothes may vary according to seasons and from one person to another (heavy or light, dark or pale clothing).

Therefore, the detection fields must remain responsive in all those situations.

2.2 Counting targets

Eight types of persons are known to circulate in an airport:

1° Enplaning passengers.
2° Deplaning passengers.
3° Escort to enplaning passengers.
4° Escort to deplaning passengers.
5° Visitors.

6° Airport operational personnel (airport employees, police, security, concession employees, etc.).

7° Ground transportation personnel (taxi drivers, bus drivers, guides, etc.).

8° Boarding personnel (pilot, flight attendants, etc.).

The relevant types of persons who constitute the target users for the detection/counting system are:

° the passengers (enplaning and deplaning), in order to be aware of the current performances of the operational facilities of the airport (types 1° and 2°);

° the escorts (meeters/greeters) and the visitors, in order to be aware of the current marketing situation and the potential of the concessions at the airport (types 3°, 4° and 5°).

The other types of persons (airport operational personnel, ground transportation personnel and boarding personnel, types 6°, 7° and 8°) are to be considered for the sole purpose of subtracting their presence to obtain actual counts of passengers, escorts and visitors.

In Appendix A, the considerations with respect to using count processing to establish the profile of target users are described.

The following paragraphs describe the three levels of counting associated with these target users; Figure 1 illustrates a model airport with its main flows of people.

2.2.1 Passengers only

This level comprises the thresholds where departing passengers and arriving passengers can be distinguished by sector. For this level, the thresholds considered are mainly:

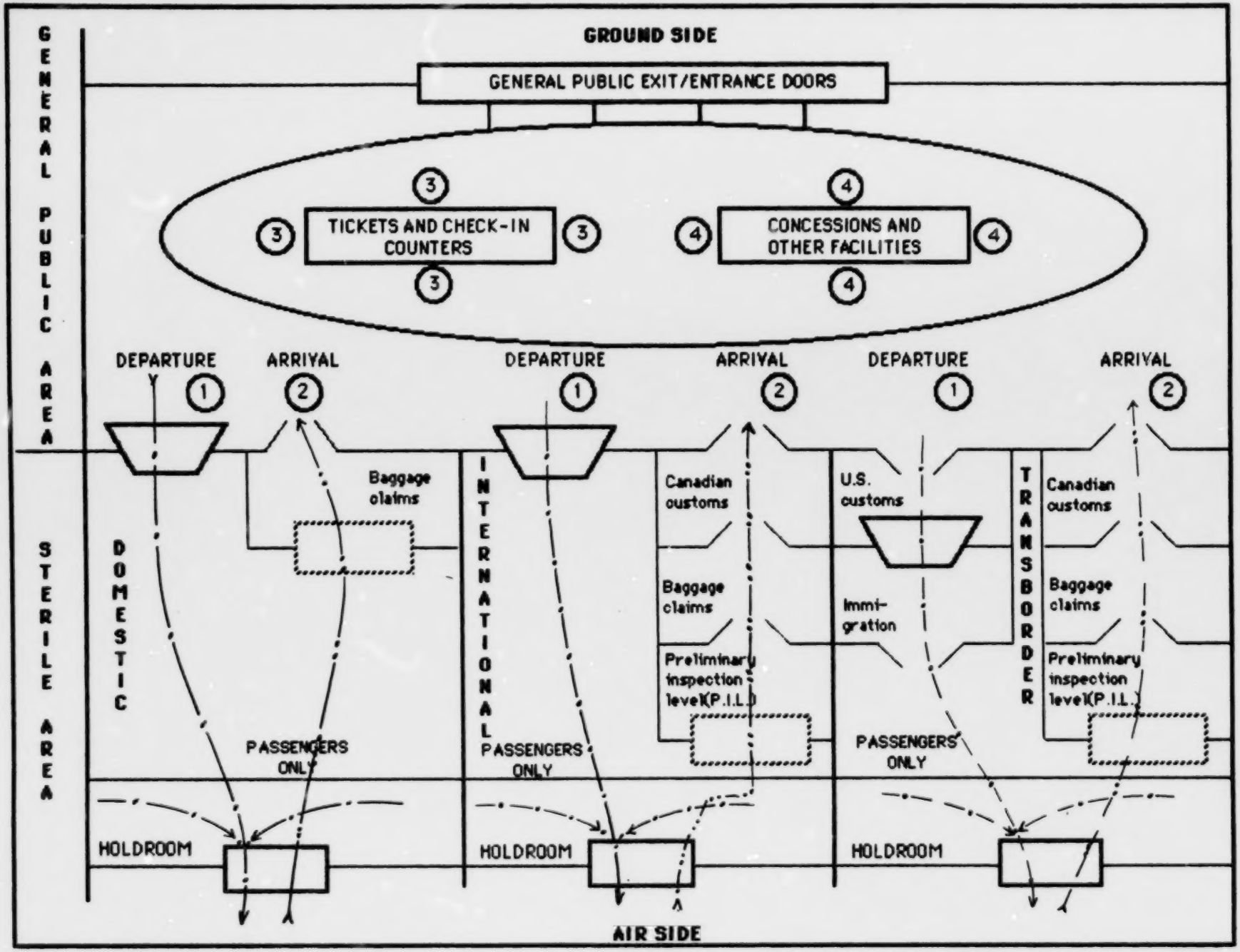
° the gates;
° the departure bottlenecks (such as security areas);
° the arrival bottlenecks.

2.2.2 Passengers and general public (minimum capabilities)

This level comprises all the passenger thresholds plus all the general public exits and entrances. In the context of the project, this level is considered the "minimum capabilities" level because it includes passenger escorts and visitors, who are of particular interest to AAG.

For this level of counting, four domains of detection areas have been defined:

° Overall counts, enplaning thresholds (security area, etc.).
° Overall counts, deplaning thresholds (bottleneck access to exits, customs, ect.), by sector.
° All the gates (enplaning/deplaning) for individual flight counts and sector identification.
° Doors for general public.


GENERAL PUBLIC AREA
STERILE AREA
GROUND SIDE
GENERAL PUBLIC EXIT/ENTRANCE DOORS
3
TICKETS AND CHECK-IN COUNTERS
4
CONCESSIONS AND OTHER FACILITIES
DEPARTURE
ARRIVAL
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2
DOMESTIC
Baggage claims
PASSENGERS ONLY
HOLDROOM
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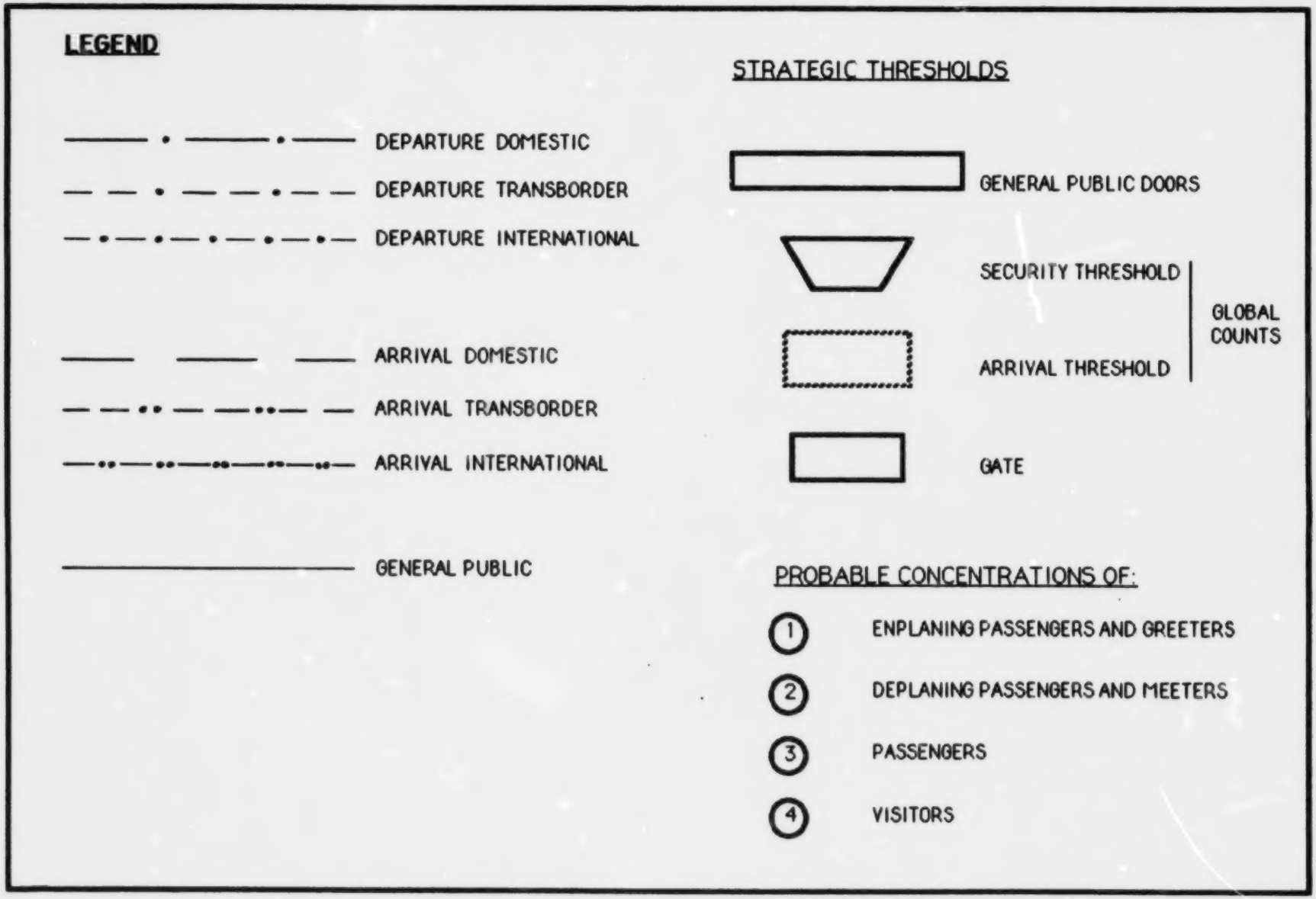


ILLUSTRATION OF MAIN PEOPLE FLOWS IN A MODEL AIRPORT

FIGURE 1

Overall counts (enplaning/deplaning) and gate counts are to an extent redundant, thus allowing, if used, for increased counting precision as well as a count of transferring passengers who do not exit the sterile area.

Gate counting is a domain which is particulary relevant in small airports, where overall counts (enplaning/deplaning) may include more than one sector; therefore, sector identification may be readily performed at gate thresholds.

In large airports, there is a very large number of gate thresholds; in these airports, sector identification (particularly of the transborder sector) is usually performed in the overall counts (enplaning/deplaning) domains. The gates are the most remotely located thresholds, and some of them are seldom used.

2.2.3 Additional capabilities

This level is considered for investigations of special aspects of user behaviour related to the operational and/or commercial facilities of the airport. Such investigations might cover:

- Evaluation of airport operations by measuring waiting time in queues and/or processing time at ticket counters, security areas, baggage claims, etc.

- Evaluation of the commercial value of the airport concessions by measuring circulation in front of and entering/exiting them.

The "additional capabilities" level relates to special investigations that are to be undertaken in a future phase of the project; consequently, this level is not integrated in the design of the detection/counting system.

2.3 Information dissemination

The system should allow for an overview of the relevant airport events (e.g.: peak flow periods) which are either continuous or transient in nature. The detection/counting signals must therefore be continuously gathered in order to provide integrated counts on an hourly basis, the hour being the minimum reporting "time slot".

Report capabilities include hourly, daily, weekly, monthly and yearly totals that should be available on demand (see 3.2.4.f).

2.4 Networked detection/counting system

For continuous gathering and processing of the counting signals, as discussed in Appendix A, all the detection areas must be networked, e.g. physically interconnected to the remainder of the system.

This requirement is valid regardless of the size of the airport; even in smaller airports (like Thunder Bay), a network configuration of the detection thresholds is essential for significant "visualisation" of airport operations. Furthermore, a network configuration assures that counting will always be processed at a cost which will likely be much lower than any daily manual gathering.

3. SYSTEM OVERVIEW

3.1 Hardware configuration

The detection/counting system is built on a four subsystem architecture. This is considered the basis of a generic design so that implementation in most airport environments can be broken down into distinct subsystems for clarity and modularity, as shown on Figure 2. These subsystems are:

a) The sensing subsystem that comprises all the detection devices.
b) The link subsystem.
c) The signal conditioning subsystem.
d) The central station subsystem.

The power supplies that feed this equipment are considered separate items. They must be configured to suit the airport environment.

3.2 Subsystem functions

3.2.1 Sensing subsystem

The sensing subsystem comprises many detection subsystems whose basic function is to "sense" people flows through relevant detection areas and send corresponding signals to the rest of the detection/counting system. Processing of these signals by the central station subsystem should allow tracking people circulating within the terminal building. Nevertheless, significant tracking requires that the sensing subsystem:

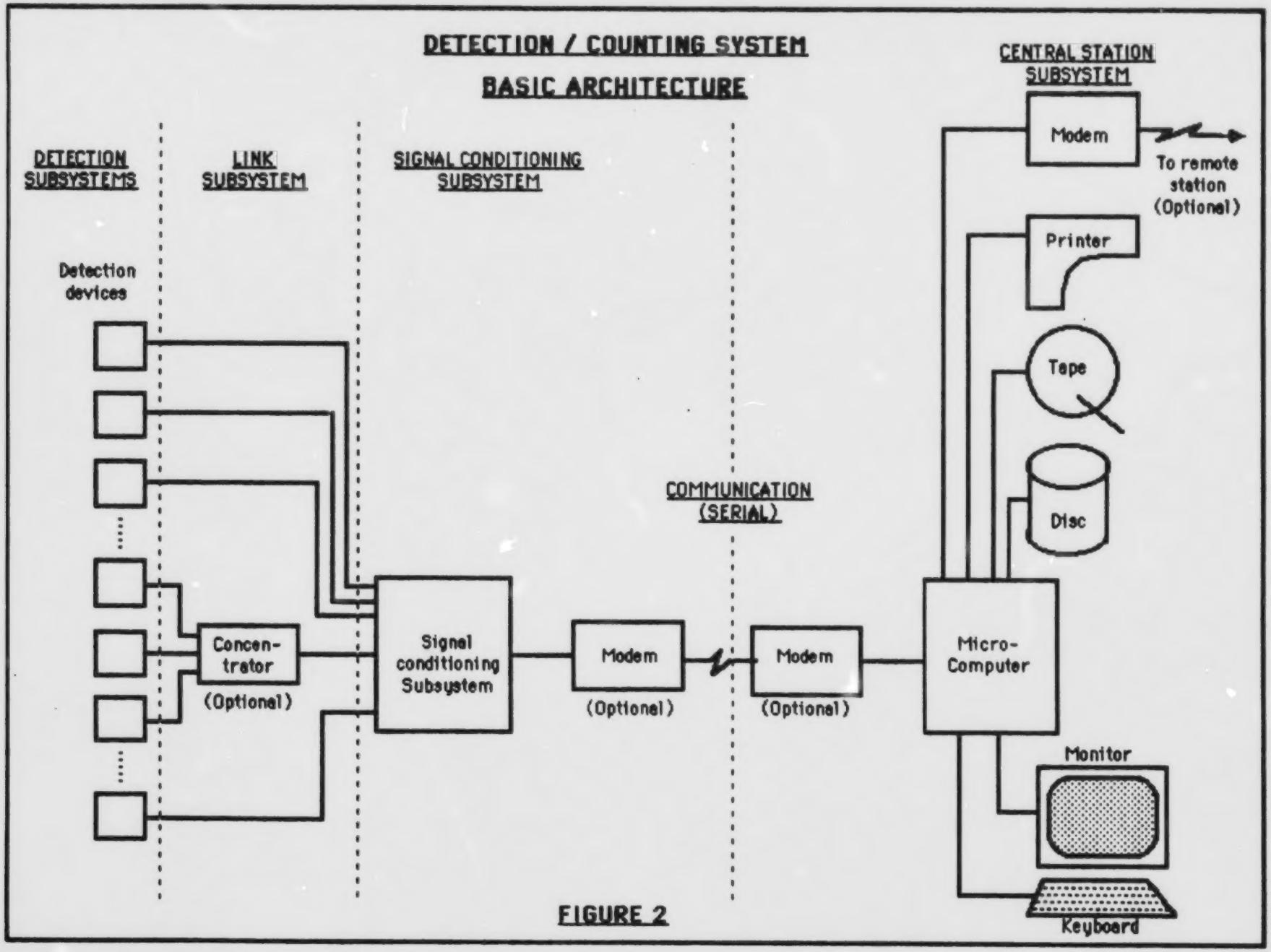

DETECTION / COUNTING SYSTEM
BASIC ARCHITECTURE
CENTRAL STATION SUBSYSTEM
DETECTION SUBSYSTEMS
LINK SUBSYSTEM
SIGNAL CONDITIONING SUBSYSTEM
COMMUNICATION (SERIAL)
Modem
To remote station (Optional)
Printer
Tape
Disc
Detection devices
Concen-trator
(Optional)
Signal conditioning Subsystem
Modem
(Optional)
Modem
(Optional)
Micro-Computer
Monitor
Keyboard

FIGURE 2

- Provide proper signals in accordance with actual people flows in a statistically predictable manner.

- Be located in strategic places where people flows are relevant to user behaviour.

3.2.2 Link subsystem

The main function of the link subsystem is to carry the detection signals from each detection device to the signal conditioning subsystem.

3.2.3 Signal conditioning subsystem

The first function of the signal conditioning subsystem is to convert the signals from the detection devices into a digital form suitable for data processing.

The second function is to multiplex and buffer all the data gathered from the link subsystem for transmission to the central station subsystem through dedicated data links.

These functions must be performed in real time so that time correlation between detection signals is preserved.

3.2.4 Central station subsystem

The central station subsystem comprises all the "intelligence" of the detection/counting system. Each detection state is received in a raw form in

order to be interpreted, processed, stored and displayed on request.

These specific functions are:

a) Signal Interpretation

Most of the detection thresholds include two or more detection devices whose detection states indicate a direction of flow and/or a number of persons being detected. The central substation must process these detection states according to a time-correlated algorithm for proper signal interpretation.

b) Correction Factors

Correction factors are applicable to any device or arrangement of devices covering a threshold in order to take into account the imprecision related to the characteristics of the threshold. For example, a security threshold may have different detection characteristics than doors for the general public; also, the density of people flow at a given threshold may have an effect on the correction factor (cf. Appendix A).

These factors should be determined at the implementation of the system and keyed in at the central station, where they may be monitored and perhaps modified (access limited by password).

c) Threshold correlations

Correlations between thresholds are performed according to time, by additions, subtractions and multiplications of specific counts in order to deduct the required numbers of terminal users (passengers, meeters and greeters, etc.), as described in Appendix A.

d) Data Acquisition

The central station should perform data acquisition of the following inputs:

i) Automatic and continuous acquisition and storage of data from the signal conditioning subsystem.

ii) Manual input of monthly and yearly passenger forecasts for direct comparison purposes.

iii) Proper interface (to be defined) with the Flight Information Display System (FIDS) for sector identification of gates and for other purposes.

e) Logging

The central station should be able to maintain for an extended period of time (e.g.: five years) historical data for retrieval, statistical analysis or reporting purposes. Data older than this should be retrieved through an archive function.

f) Screen Displays and Reports

The screen displays and reports should allow for the appropriate views and report generation for all the counts of each threshold, accumulated and accessible on an hourly, daily, weekly, monthly and yearly basis.

These counts should be displayed and identified as follows:

- Number of enplaning passengers by sector and total.
- Number of deplaning passengers by sector and total.
- Number of estimated meeters and greeters.
- Number of total airport users.
- Raw threshold counts, without correction factors.
- Others to be defined.

All displays should be refreshed as data is being updated, when applicable.

g) Reports

The central station should be able to list all the operational thresholds, including the identification, location, parameters, etc.

Also, any other user defined reports should be available.

h) Menu Driven Operations

The central station should allow the operator to navigate through the system functions via comprehensive, "user friendly" menus.

Access of any menu should not interrupt data polling and processing.

i) Monitoring

The central station should monitor the system on a continuous basis in order to diagnose and report the operations of processor, memory, peripherals, signal conditioning subsystem, link and sensing subsystems.

In particular, the sensing subsystem should be monitored automatically, in real time, indicating status device in the following situations:

i) The detection device has been in a continuous detection state for a certain period of time (for example: one half hour) upon corresponding status indication.

ii) The detection device has not been operated (detected) over a certain period of time (for example: 6 hours).

4. SENSING SUBSYSTEM

4.1 Detection technologies

4.1.1 Performance criteria

Two main parameters must be considered:

a) The precision of the detection field coverage, in order to be able to predict all cases of presence and absence of persons within the field.

b) The responsiveness of the detection devices that is suitable for counting purposes. It must provide a multi-state signal, in which each state is related to the actual number of persons in the detection field for a period of time. The simplest detection system provides a two-state signal related to the presence or absence of one person at a time in the detection field.

An arrangement of many two-state devices may be considered in order to increase accordingly the responsiveness of the detection system.

Current technologies for detection applications are described in the following paragraphs.

4.1.2 Micro-wave

A device generates a micro-wave field that fills a volume. When a person enters this volume, the micro-wave field is disturbed; this disturbance activates an adjacent receiver and triggers the detection state.

This technology is not suitable for the following reasons:

a) The detection field lacks precision because micro-wave propagation is not completely predictable, being influenced by conducting and reflecting elements.

b) Most micro-wave detectors do not have the appropriate responsiveness for the generated detection field: the detection state is the same for one or many persons in the detection field.

c) Experience with micro-wave detection devices raises some concern about harmful effects on people with heart conditions.

4.1.3 Infra-red vision (passive infra-red)

The area of interest is "seen" in the infra-red spectrum by a device that is sensitive to rapid changes of thermal energy. A person who enters the field of view (which is the detection field), changes the thermal energy and thus activates the infra-red device into the detection state.

For reliability and sensitivity purposes, the principle of detection is based on measuring of the differential energy level between two infra-red sensitive components; triggering occurs when a person moves within the detection field, which must be relatively large.

This condition may cause responsiveness deteriorate in the following way: two persons in the detection field will make one count; one person, depending on his motion, may make more than one count. This critical lack of responsiveness makes this technology inappropriate for counting purposes.

4.1.4 Active infra-red

A device emits an infra-red beam (usually pulsed for internal recognition) through the area of interest. When a person blocks or reflects this beam, an adjacent receiver is activated into the detection state.

This technology is suitable because the emitted-received beam can be aimed in such a way as to precisely define the detection area. In addition, detection can be triggered by either blocking or reflecting the beam; this feature increases the implementation possibilities. Nevertheless, the detection devices can only detect one person at a time and the detection field must be adjusted accordingly. This is relatively easy, since infra-red beams can be well defined.

4.1.5 Ultra-sound

Two main principles can be considered. First, a device generates an ultra-sonic field that fills a volume. When a person enters this volume, the Doppler effect (change in the field frequency) is created and detected by an adjacent receiver, which triggers the detection state.

The second principle is based on the emission of a pulsed ultra-sonic beam which is reflected by a background surface. The device senses the time required for the reflected pulses. The detection field is thus created between the device and the background surface. When a person enters the zone, the pulsed beam is reflected from that person. The time required to receive the reflected pulses is reduced. The decreased propagation time triggers the detection state. Such devices can also measure the distance between the incoming person and the detection device.

The first principle is not suitable for the following reasons:

a) The detection field lacks precision because ultra-sonic propagation is not completely predictable, being influenced by reflecting elements and air movements.

b) Ultra-sonic detectors for this application do not have the appropriate responsiveness for the generated detection field: the detection state is the same for one or many persons in the detection field.

The second principle may be suitable in some cases where distance measurement of the detected person is required for appropriate responsiveness in a complex area of interest. But this requirement also involves additional measurements (e.g.: a current proportional to distance).

4.1.6 Video

The area of interest is "seen" by a T.V. camera, thus forming the detection field which can be precisely defined. The resultant video signal is stored and continuously compared to previous video signals. Changes in the video signal are caused by persons who enter or exit the detection field: these changes are processed according to a procedure that may be simple (giving one detection for any change in the detection field) or very complex (computer based analysis of the digitized signal that is put in a matrix form) in order to perform counts of persons being in the detection field.

The simple processing procedure is not suitable because the detection state is the same for one or many persons in the detection field.

The complex processing procedure may be quite suitable for an "open space" type area to estimate the number of persons in such an area. On the other hand, this requires a specific implementation study and elaborate software, thus raising cost considerations. An incidental advantage of using video technology is the availability of a T.V. image of the detection field for user behaviour observations.

4.1.7 Weight detection

Two principles can be considered:

The first is a pressure contact that closes or opens upon the application of pressure (the weight of a

person). A person walking over a mat or sitting on a seat that contains pressure contacts will be detected.

The second principle is a large rigid scale plate that actually weighs the people on it (load cells or pressure tube principle). Resultant weight may be used for an estimate of the number of persons in the weighed area.

The following serious constraints apply to the use of this technology:

a) Pressure mats must be put under a carpet. In many cases, there are no carpets in the area of interest.

b) Pressure mats are relatively fragile devices and may break down in dense circulation.

c) Responsiveness of pressure mats is inadequate to "sense" people walking because of irregular steps.

d) Scale plates may require major structural modifications in order to fit flush to the floor.

4.1.8 Radio-frequency resonance

A radio frequency field is generated in the area of interest. The person to be detected must wear a specific tag that reacts to the R.F. field and generates an auxiliary signal. Upon the detection of this signal, an adjacent receiver triggers the detection state.

This technology is not suitable for the following reasons:

a) The detected person must wear a tag. This requirement is not applicable to passengers or general public.

b) Radio-frequency technology could be applied to airport operating personnel, whose tags could be used to subtract their contributions from the "regular" detection/counting system. One factor that might prevent this: the radio-frequency field has inadequate responsiveness (one detection state is triggered even though more than one person is within the field). Another factor is that it would require a parallel detection system specifically aimed at airport operational personnel. Potential objections are quite obvious in the context of labour relations, physical implementation and processing complexity.

c) Radio-frequency fields may create interference that could affect airport operations; their effects on people who suffer from heart conditions are not fully know.

4.1.9 Summary of technologies

Based on these technical considerations, the following preliminary conclusions can be drawn:

1° Micro-wave technology is not appropriate.

2° Passive infra-red technology is not appropriate.

3° Active infra-red technology is suitable.

4° Ultra-sound technology could be suitable where a distance measurement is required.

5° Video technology could be suitable for a particularly critical open area.

6° Weight detection technology could be considered in very special cases of open spaces.

7° Radio-frequency resonance is not appropriate.

4.2 Characterization of detection areas

4.2.1 Threshold category

In the threshold detection area, detection is based on "walk-through" behaviour. Four types can be defined:

a) Narrow-one-way (NOW): one person at a time, in one direction only.

b) Narrow-two-way (NTW): one person at a time, in either direction.

c) Wide-one-way (WOW): possibility of two to four persons at a time, in one direction only.

d) Wide-two-way (WTW): possibility of two to four persons at a time, in either direction.

With reference to the levels of counting as described in section 2.2.2, the "minimum capabilities" level comprises only threshold detection areas.

4.2.2 Typical locations for threshold detectors

a) Side check counter (NOW):

This is a counter where a person stops for identification or baggage check by a security attendant and then walks along. One person at a time, one direction only (NOW). Examples: immigration counter, preliminary and secondary customs, etc.

b) Detector loop (NTW):

This is a walk-through vertical detector loop as found in enplaning security areas to search for metal objects worn by passengers. One person at a time, two directions (because sometimes a passenger may have to walk back and forth for proper check in the detector loop).

c) Check gate (NOW):

This threshold looks like an open gate where a security attendant checks a specific passenger's document (boarding pass, customs card, etc.). One person at a time (but following each other closely), in one direction only.

d) Door:

The door threshold is defined according to its width and direction:

- One-person/one-way (NOW).
- One-person/two-way (NTW).
- Two-person/one-way (WOW).
- Two-person/two-way (WTW).

A one-person door is typically three feet wide and a two-person door six feet wide.

Doors may be of the swing design or of the slide design. This does not actually affect the threshold configuration, but in the swing design, one has to consider the side of the door opening for proper detection device location. Furthermore, a slide design door is more likely to be a two-way door.

e) Escalator:

Escalators are one-way by definition. In practice they exist in two widths:

- Narrow (one-person) escalator (NOW).
- Wide (two-person) escalator (WOW).

It may be worthwile to note that detection/counting, particularly in the wide escalator, may present some difficulties: persons on escalators are often closer to each other than in other circulating areas; furthermore, the escalator environ-

ment (width, maintenance space, irregular height of ceiling) impedes proper device location. Because of those constraints, only the narrow escalator is considered a practical detection threshold.

f) Staircase:

Staircase areas are found to be of the two or four person width, one or two-way, giving the following combinations:

- Two-person/one-way (WOW).
- Two-person/two-way (WTW).
- Four-person/one-way (WOW).
- Four-person/two way (WTW).

A one-way staircase may be normally one way for passenger circulation but two way for airport operation personnel working in a certain area.

If this is known, "backward counts" may be used to subtract the airport operational personnel contribution from the passengers counts.

g) Corridor:

The corridor areas are found to be of the three or four person width, one or two-way, giving the following combinations:

- Three-person/one-way (WOW).
- Three-person/two-way (WTW).
- Four-person/one-way (WOW).
- Four-person/two-way (WTW).

Likewise, a normally one-way corridor may be used, as in the staircase areas, to subtract airport operational personnel by counting backward circulation.

4.2.3 Open space category

In open space detection areas, detection is based upon the occupancy of a space. Two types are defined:

a) Open-space-queuing (OSQ): a space where a queue is likely to occur (in front of processor, e.g.: counter, security check, etc.). One person or many persons at a time may be involved.

b) Open-space-circulating (OSC): a space where people are circulating in unrestricted ways (e.g.: holdrooms, in front of concessions, etc.). One person or many persons at a time may be involved.

This category of open space detection area exists only in the "additional capabilities" level.

4.2.4 Typical locations for open space detectors

a) Queues (OSQ):

A queue occurs, according to natural passenger behaviour, when people have to wait in front of a processor. The space usually dedicated for queuing is generally a longitudinal irregular area, perpendicular to the processor, where people stand still or slowly move forward with luggage dragged along.

b) Counter front (OSC):

A counter front is the space usually occupied by only one passenger being served at a counter.

c) Shop-front of concession (OSC):

This is the space occupied by many persons walking in an unrestricted manner in front of concessions. The width of the space to be considered is about six feet.

d) Seat (OSC):

This is a space where a person sits and waits (e.g.: holdrooms, etc.).

4.3 Design guidelines

4.3.1 Importance of threshold detection areas

The threshold detection areas are the most numerous and the most critical for proper design of the sensing subsystem. In fact, the "minimum capabilities" level (as described in paragraph 2.2.2) comprises solely threshold detection areas. Consequently, the design guidelines should comprise an overall view of all the thresholds in order to have a consistent design throughout the sensing subystem.

4.3.2 Implementation/ maintenance efficiency

Implementation/maintenance efficiency is mainly based upon:

a) Simplicity of the detection device installation to obtain a proper detection field in the areas of interest with minimum environment disturbance.

b) Connections to the rest of the system (power supplies and signal conditioning) with minimum electrical dissimilarities.

c) Standardization, as much as possible, by the use of similar devices and similar threshold configurations, to reduce inventory requirements.

4.3.3 Count reliability

Count reliability is primarily based upon:

- the precision and responsiveness of the detection fields;

- the choice of the counting thresholds in order to obtain relevant counts and uniformity of circulation.

It is understood that high density people flows at a counting threshold may significantly reduce the reliability of counts; therefore, when choosing a counting threshold, one should consider the advantage of steadiness of people flow that can be created by an upstream processor.

4.3.4 Optimization

Optimization of the sensing system is based mainly upon the economy:

° of counting thresholds, keeping in mind that an alternative counting threshold may replace two or three others;

° of detection devices, by an appropriate threshold configuration;

° of cabling, by reducing wiring distance or by the use of appropriate cables and/or multiplexers.

4.3.5 Active infra-red technology

The choice of active infra-red technology for all detection thresholds is recommended because:

° the devices are small, rugged, reliable, easily powered; furthermore, they can be located and oriented to suit the particular requirements of most of the thresholds;

° the infra-red beam (pulsed) is practically immune to external light and other interference; furthermore, it is completely invisible and does not create any interference;

° only one or two basic types of devices can be configured for different threshold types.

4.4 Threshold configurations

4.4.1 Horizontal beams

Generally, a horizontal beam is used when only one person is to cross the detection threshold at a time. It is operated in either through beam or retro-reflective mode, the second usually being more convenient because both devices are on the same side of the threshold.

If one wants to know the direction of flow, a second horizontal beam is added in such a way that the sequence of beam blocking can be easily interpreted to determine the count direction.

Note: A stand-alone detection system is offered by one potential supplier (Honeywell). It comprises a set of horizontal beams interfaced with a local processor.

The detection area is formed by two long panels (approximately 8 feet).

The supplier claims that the system can count and determine the direction of circulation of persons walking between these two panels. It can also detect access cards.

The relatively high cost (about $ 10 000 for one threshold) and the dimensions of the panels raises some doubts about the suitability of such a system in view of the system requirements.

Typical horizontal single beam thresholds are:

- check counter;
- check gate;
- narrow escalator (one person).

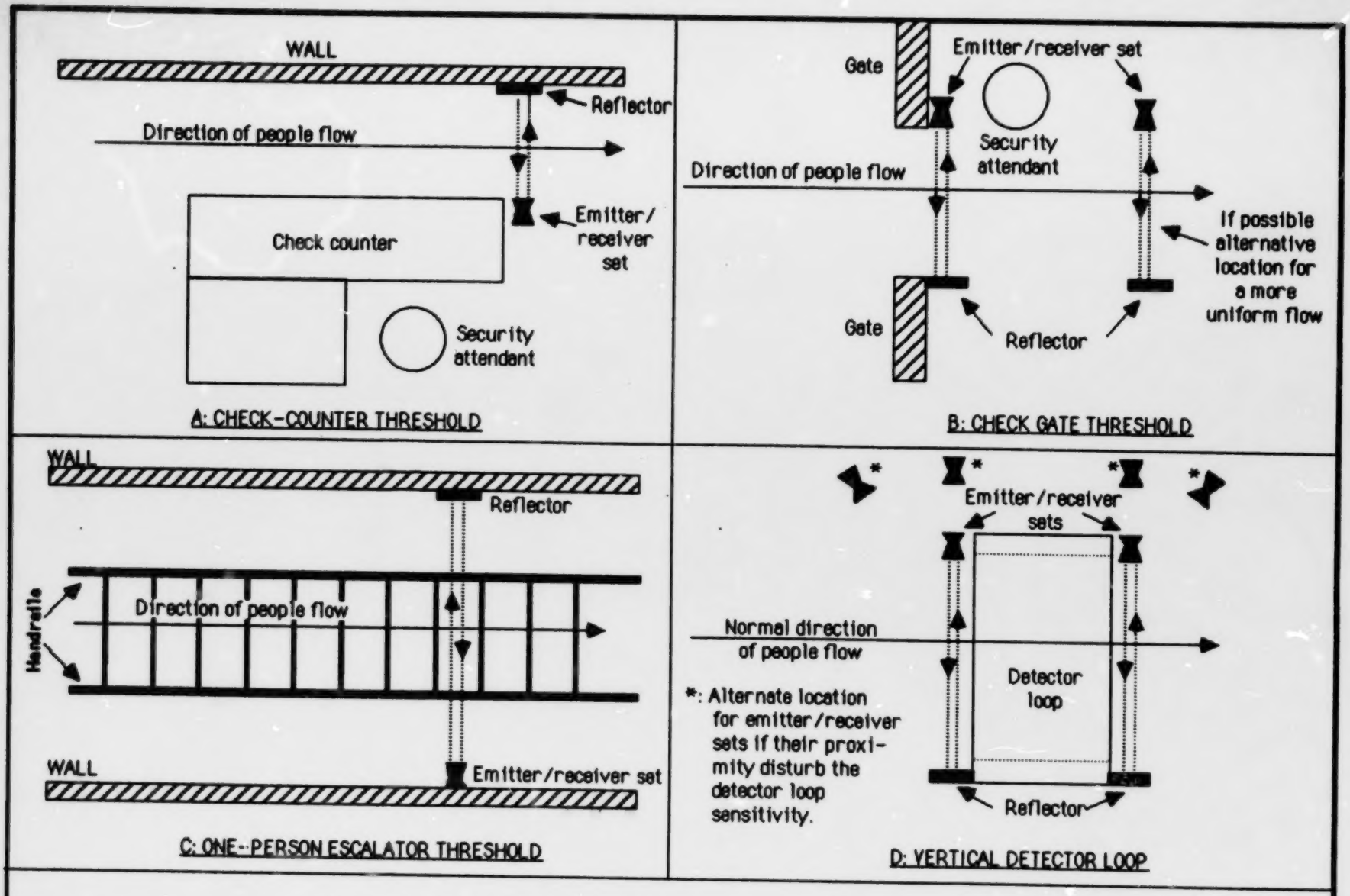
These are shown on Figures 3a, 3b and 3c.

The check gate usually experiences high density circulation when persons are closely following each other. If the beam is located immediately after the check procedures, then the space between each person is likely to increase, as is the count reliability.

In the narrow escalator, the emitter/reflector/receiver assembly should be put in the middle of the escalator: flow is then more uniform and the installation is usually more convenient than at either end of the escalator.

A typical horizontal double-beam threshold is the vertical detector loop in the security area, as shown on figure 3d.

The proximity effect of the emitter/receiver sets on the vertical detector loop must be taken into account at installation time; if necessary, they should be located farther a part in order to preserve the detection ability of the device.



TYPICAL HORIZONTAL BEAM THRESHOLDS (PLAN VIEW)

FIGURE 3

4.4.2 Overhead beams

Overhead beams are considered when the horizontal beam would not be appropriate, as in the following cases:

a) Installation constraints, as experienced with some doors (particularly adjacent doors).

b) Wide threshold, where more than one person at a time can pass; in these cases, the horizontal beam lacks responsiveness. An overhead view of the threshold allows for "seeing" the entire width by installing the required number of emitter/receiver sets to obtain the appropriate responsiveness.

Note: Information was obtained from another supplier (B.G. Checo) about an overhead detector used in Europe for counting persons in a subway environment. It is a modular stand-alone system that can cover a width of up to five (5) meters and count people in either direction simultaneously with a reliability of better than 3%. The system is a prototype and was designed for continuous, bi-directional high density circulation. Cost is from 94700F. ($19 130*) for the basic master unit covering a width of 0.7 m; it increases by 18700F. ($ 3 780*) for each slave unit covering an additional 0.35 m, for a maximum of twelve slave units (* plus customs, taxes and transport).

4.4.3 Basic set-up of overhead detection

A specifically oriented pulsed infra-red emitter/receiver set located over the person to be detected constitutes the basic set-up: the infra-red beam is projected downward; the person to be detected passes beneath it, reflects the incident beam toward a dedicated receiver and thus triggers a count.

This system is used in the diffuse reflection mode; retro-reflective, as in the horizontal beam, cannot be used unless the reflector is fixed on the floor, which is obviously not practical.

A relatively intense beam should be used to generate sufficient reflected energy even from dark surfaces (hats, hair, clothes, skin); the beam and the adjacent receivers must be oriented in such a way as to avoid stray reflections from the floor and other low objects (such as luggage).

Clearly, a major installation aspect of overhead emitter/receiver sets is the height of the devices; the higher the emitter/receiver set, the weaker the beam and the less precise the detection field. Practically, according to device characteristics and beam geometry, installation height should not be more than nine (9) feet. In some high ceilings, an installation bracket should be used for proper height adjustment.

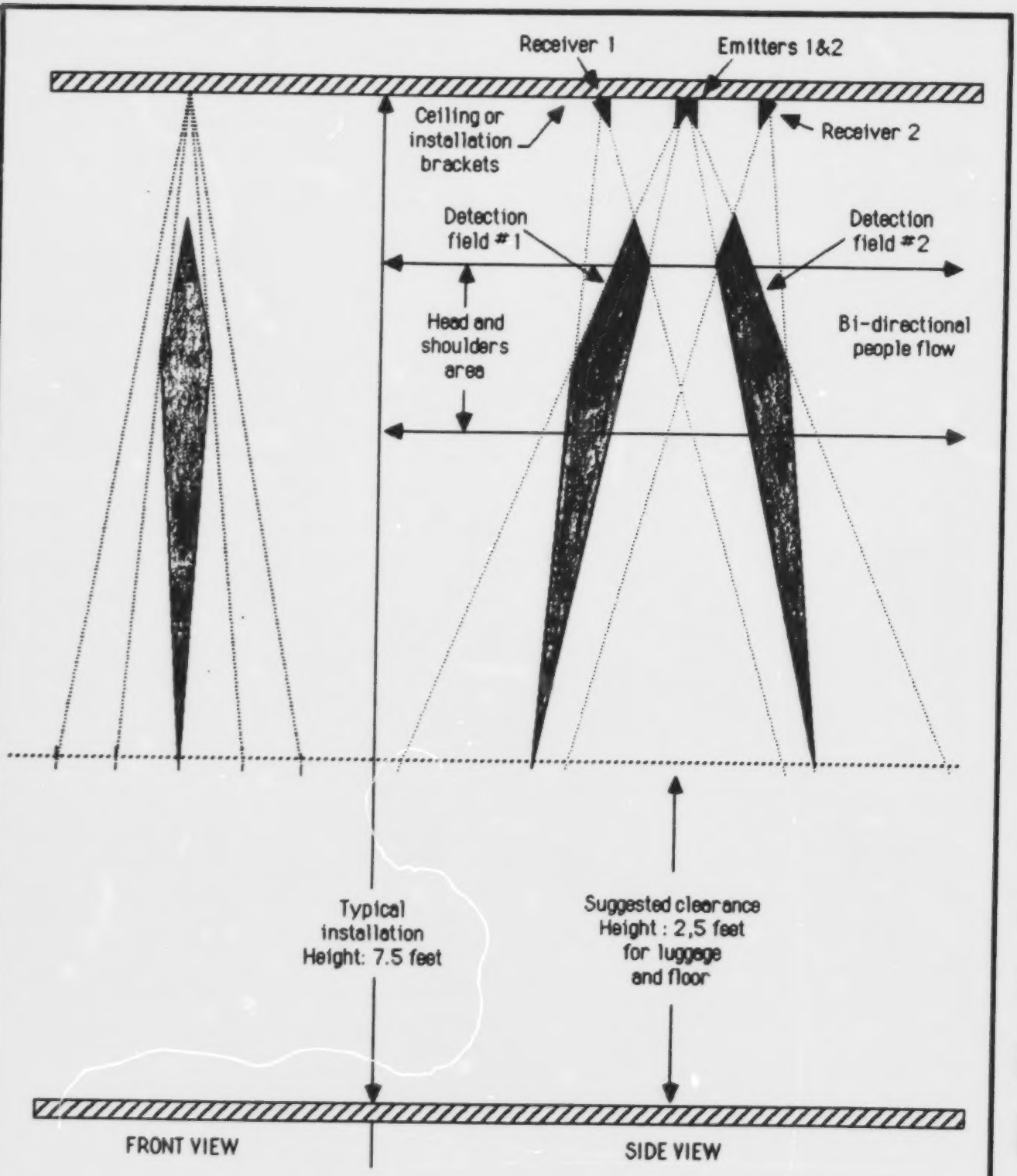
A basic emitter/receiver set-up is illustrated on Figure 4. The installation height considered is seven and a half feet, which could be a typical height for illustration purposes.

Figure 4 shows two detection fields for detection of the direction of flow. In a one way set-up, only one detection field is required.

After proper orientation and spacing of the emitters and receivers, the detection field is defined by the intersection of the conical volume covered by the emitted beam and the conical volume seen by the receiver. The angles considered were 10 and 20 degrees respectively, which are typical values for such an application.

The detection field is thus well defined because this is the only spot from where the emitted beam can reach the receiver after reflection from the detected person.

Experiments and field trials should allow for final adjustments, if necessary, in order to obtain satisfactory responsiveness. The angles and heights of the emitting and receiving devices, as well as the distance between them, are relevant parameters for these adjustments. Thus, the supporting brackets should allow for these basic adjustments.



TYPICAL BASIC SET-UP FOR OVERHEAD BEAMS

FIGURE 4

4.4.4 Wide thresholds/multiple set-ups

In wide threshold conditions, more than one person can pass at a time and must therefore be detected.

In order to properly cover the threshold width, a certain number of basic emitter/receiver sets is required, depending on the maximum number of persons to be detected.

A rule of thumb to determine the appropriate number of basic emitter/receiver sets is expressed by the following equation.

$$Nd = (2 \times Np) - 1$$

Where,

Nd is the number of required devices;
Np is the number of persons who can walk through the threshold simultaneously.

The underlying assumptions are:

a) One person can trigger either one or two adjacent receivers (if he passes right under one or between two).

b) Two persons can trigger either two separate receivers or two pairs of adjacent receivers or three adjacent receivers.

c) Three and four person detections follow the same assumptions as illustrated on Table 1 for purposes of clarity.

d) A person is assumed to occupy a one-and-a-half foot width; consequently, detection (emitter/receiver) sets equally spaced throughout the threshold width should be provided for appropriate responsiveness.

e) If two-way detection is required, each detection set must be doubled (as illustrated on figure 4) Then it is assumed that both sets will be triggered by the same person walking along (circulation parallel to threshold axis).

TABLE 1: LOGIC STATES RELATED TO OVERHEAD DETECTION

POSITION OF DETECTION SETS (X INDICATES TRIGGERING)							GENERAL LOGIC STATE	CORRESPONDING NUMBER OF PERSONS
			X				1 SEPARATE	1
		X	X				2 ADJACENT	
		X		X			2 SEPARATE	2
		X	X	X			3 ADJACENT	
	X	X		X	X		2 PAIRS OF TWO ADJACENT	
	X		X		X		3 SEPARATE	3
	X	X	X		X		3 ADJACENT AND 1 SEPARATE	
X	X		X	X		X	2 PAIRS OF 2 ADJACENT AND 1 SEPARATE	
X	X	X		X	X		3 ADJACENT AND 2 ADJACENT	
	X	X	X	X	X		5 ADJACENT	
X		X		X		X	4 SEPARATE	4
X	X	X		X		X	3 ADJACENT AND 2 SEPARATE	
X	X	X		X	X	X	3 ADJACENT AND 3 ADJACENT	
X	X	X	X	X	X	X	7 ADJACENT	

4.5 Open space configurations

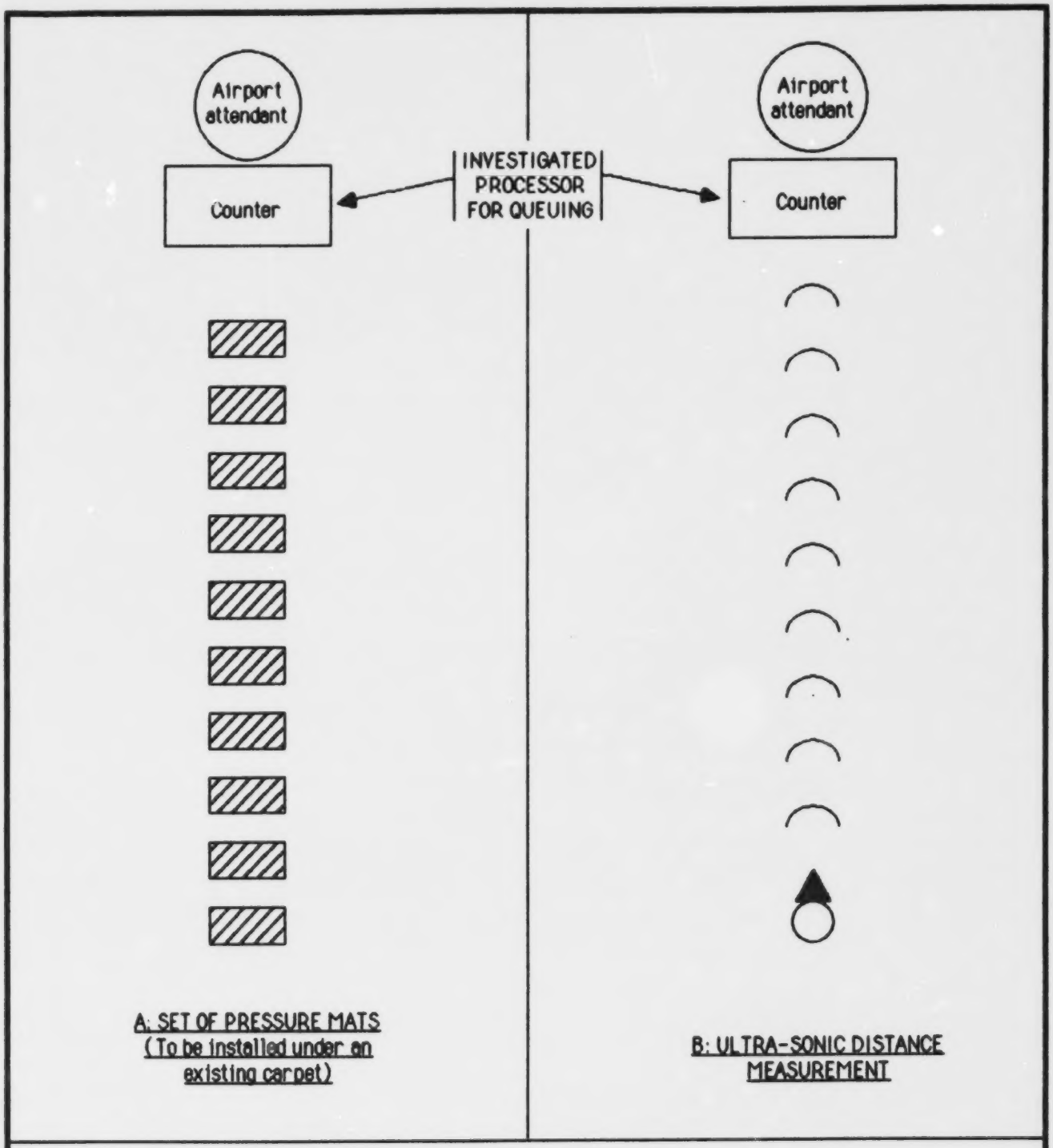
4.5.1 Queues

To measure queue lengths, two different technologies may be selected and applied as follows:

a) Weight detection: many pressure mats are installed under a carpeted area where a queue is likely to occur. When there is no queue, occasional contacts indicate walking in an unrestricted manner over the pressure mats. Constant contacts occuring close to the processor and covering more and more of the detection area indicate that a queue is building up. This technology requires a carpeted floor. It has no limitation in queue length. Figure 5A illustrates this configuration.

b) Ultra-sonic distance measurement: an ultra-sonic device is installed behind the area where the queue is likely to occur and is aimed at the processor under study, thus establishing a maximum reference distance (which is actually measured by a current from the device). If this distance varies in an inconsistent manner, it indicates that people are walking unrestrictedly between the target processor and the ultra-sonic device. But if a constant shorter distance is being measured, it is an indication that a queue is occuring.

   This technology requires that the device be installed in front of the processor; the measuring distance should not be greater than 20 feet.



QUEUE CONFIGURATION

FIGURE 5

Figure 5B illustrates this configuration.

4.5.2 Counter front

The occupancy in front of a counter may be determined by the use of the following technologies (which are not exhaustive):

a) Weight detection: the pressure mat is installed under a carpet in front of the counter; any person standing on it is then detected. This requires a carpeted floor.

b) Ultra-sonic detection: an ultra-sonic device is properly installed on the counter in such a way as to aim at the area where a person is likely to stand. Reflections of the ultra-sonic beam from the detected person trigger the detection state.

c) Active infra-red detection: an emitter/receiver set is properly installed on the counter in such a way as to aim at the area where the person is likely to stand. Reflections of the infra-red beam from the detected person trigger the detection state.

4.5.3 Front of concessions

Behaviour in this type of open space area is quite unpredictable and proper counting could require sophisticated devices such as video analysis.

Simpler technologies also can be considered, with their associated draw-backs:

° weight detection: a large rigid scale plate weighs and estimates accordingly the number of persons being in the weighed area; this may require major implementation work.

° multiple beams (infra-red or ultra-sonic): many beams are projected into the area of interest; the number of blocked and/or reflected beams relates (according to a function) to the number of persons being in the area; the implementation, calibration and interpretation of the resultant signals may require intensive work.

Investigations of front-of-concessions may extend to counting persons who enter and exit the concession. Detection as in the threshold approach should be considered.

4.5.4 Seats

Monitoring seats in an open space is mainly used in order to estimate the number of persons in a larger area (like a waiting room or holdroom), assuming that persons in these rooms would sit to wait. Standing persons would not be detected, but occupancy of the seats could provide some relevant information. One simple device to be considered is a pressure cushion that can be incorporated in the seat: when a person sits, detection occurs with a contact closure.

4.6 Operational constraints

4.6.1 Environmental

The environmental specifications are mainly related to the constraints and limitations discussed in section 2.1.

4.6.2 Accuracy of counts

The sensing subsystem is designed to give full counting reliability: each count should correspond to one and only one person (within an expected level of accuracy).

This is easily achievable for simple thresholds (one person only, horizontal retro-reflective beams) but can be more difficult for the overhead beam thresholds, where neither the diffusion characteristics of detected persons nor the resultant logic states have been investigated in depth. Practical data from previous implementations are lacking for use in specifying a predictable counting scheme.

4.6.3 Signal format

The signals collected from the detection devices should be compatible with the rest of the system. This may require additional devices (relay, transistor interface).

4.6.4 Mounting of emitter/receiver sets

The emitter/receiver set is the basic element of any detection threshold. In the horizontal beam configuration, they are used in the retro-reflective mode so that both devices should be parallel and aimed at the reflector. They can thus be located in the same casing.

In the overhead beam, the emitter and the receiver must be individually oriented. Mounting brackets should permit this kind of adjustment. In addition, a local connector should be available to connect the appropriate measuring instruments while adjusting the devices.

Table 2 indicates the number of emitter/receiver sets as related to the type of threshold.

TABLE 2: NUMBER OF EMITTER/RECEIVER SETS RELATED TO TYPE OF THRESHOLDS

THRESHOLD WIDTH: MAXIMUM NUMBER OF SIMULTANEOUS PERSONS	TYPE OF THRESHOLDS			
	ONE-WAY		TWO-WAY	
	HORIZONTAL BEAM	OVERHEAD BEAM	HORIZONTAL BEAM	OVERHEAD BEAM
1	1	1	2	2
2	-	3	-	6
3 *	-	5	-	10
4 *	-	7	-	14

* These threshold widths imply more complex processing for count interpretation and should be avoided as much as possible.

4.6.5 Power supply

All the emitter/receiver sets and the associated electronics (amplifiers, relays, etc.) should be powered through dedicated wires from an uninterruptable power supply, either locally or remotely, depending on the airport facilities.

This power supply should include protection devices to limit current and voltage surges in case of short/open circuits as well as transients in the primary supply.

The voltages available at the emitter/receiver sets and at the electronic equipment if any, located close by, must not be higher than 24 volts. The available current at any detection threshold must not be higher than 2 amperes.

4.6.6 Response time

The response time refers to the infra-red receivers and their associated trigger circuits. It is defined as the minimum time that can be measured between two counts at the output of the trigger circuits. It is a value based solely on the technical specifications of the devices and the associated electronics. The response time should not be greater than 50 milliseconds.

4.6.7 Responsiveness

The responsiveness of a detection threshold refers to its detection field combined with the response time and the reset time of the detection devices and the

associated electronics; it is defined as the maximum number of persons per unit of time that can be counted at this detection threshold.

Therefore, the detection field must be as thin as possible in order to avoid the entrance of one person within the field before the exit of the previous person.

Theoritically, up to a certain flow density, counts are distinct, but flow density in excess of the responsiveness of the detection threshold would be perceived as a continuous detection state.

Responsiveness cannot presently be specified because of lack of experimental data but should be optimized and determined for each detection threshold at implementation time. Furthermore, correction factors should be included in the processed counts at the central station, in order to take this threshold limitation into account.

4.6.8 Discretion of emitter/receiver sets

The emitter and receiver devices, as well as their associated wiring and electronic circuits, must be as discreet as possible to the persons circulating in the airport. Furthermore, detection state should not create any audible nor visual phenomenon like the "click" of a relay or the lighting of a pilot lamp that could be perceived by a person at the vicinity of the detection threshold.

5. LINK SUBSYSTEMS

5.1 Transmission medium

The detection signals (contact closure or opening, transistor sinking or sourcing current) must be picked up and sent to the remainder of the system through transmission medium which can be:

a) Hardwire twisted pairs or coaxial cables.

b) Carrier current transmission on an existing wiring (security lighting for example).

c) Radio transmission.

d) Infra-red transmission (needs line of sight between emitter and receiver).

5.2 Environmental constraints

The following environmental considerations apply:

- usually suspended ceilings are suitable for wiring purposes;
- an airport is often subjected to modifications: this limits the use of carrier current or infra-red transmissions;
- electromagnetic interference is particularly critical; carrier current and radio transmission could create or suffer from such interference.

5.3 Selection for the link subsystem

The link subsystem should bring the counting signals to the signal conditioning subsystem in a uniform format and preferably in its raw form (contact closure or opening, transistor sinking or sourcing current) throughout the system for implementation/maintenance efficiency.

Some transmission mediums (e.g.: carrier current, radio and infra-red transmission) by nature require a modulation/demodulation process, which increases the complexity of the system and accordingly decreases its reliability.

Given the environmental constraints and the above-mentioned considerations, dedicated hardwire (twisted pair and/or coaxial) is selected for the transmission medium.

6. SIGNAL CONDITIONING SUBSYSTEM

6.1 Transparent interface

There are two basic functions related to the signal conditioning subsystem (as seen in paragraph 3.2.3):

- signal conversion;
- multiplexing/buffering.

Combined with the link subsystem, the signal conditioning subsystem constitutes a transparent interface between the sensing devices and the central station subsystem.

6.2 Physical description

The signal conditioning subsystem comprises the following equipment:

a) Concentrator of detection devices to aggregate the detection signals of a group of detection devices. A typical concentrator can handle up to six detection devices; the aggregated signals are transmitted on hardwire (twisted pairs) which may be connected to other concentrators. Typically, eight concentrators can be connected to the same hardwire.

b) Data multiplexer to interface the concentrators and the central computer. The multiplexed data are transmitted on a RS-232-C type communication link. Typically, up to three data multiplexers can be connected to the central station.

c) Accessories to extend the communication link distance (such as "limited distance data sets") in the case of larger airports when the multiplexers are far away from the central computer.

d) Accessories to multiplex communication links (such as a RS-232 multiplexer) when more than one data multiplexer are used.

A typical configuration is illustrated in Figure 6.

6.3 Centralized versus distributed

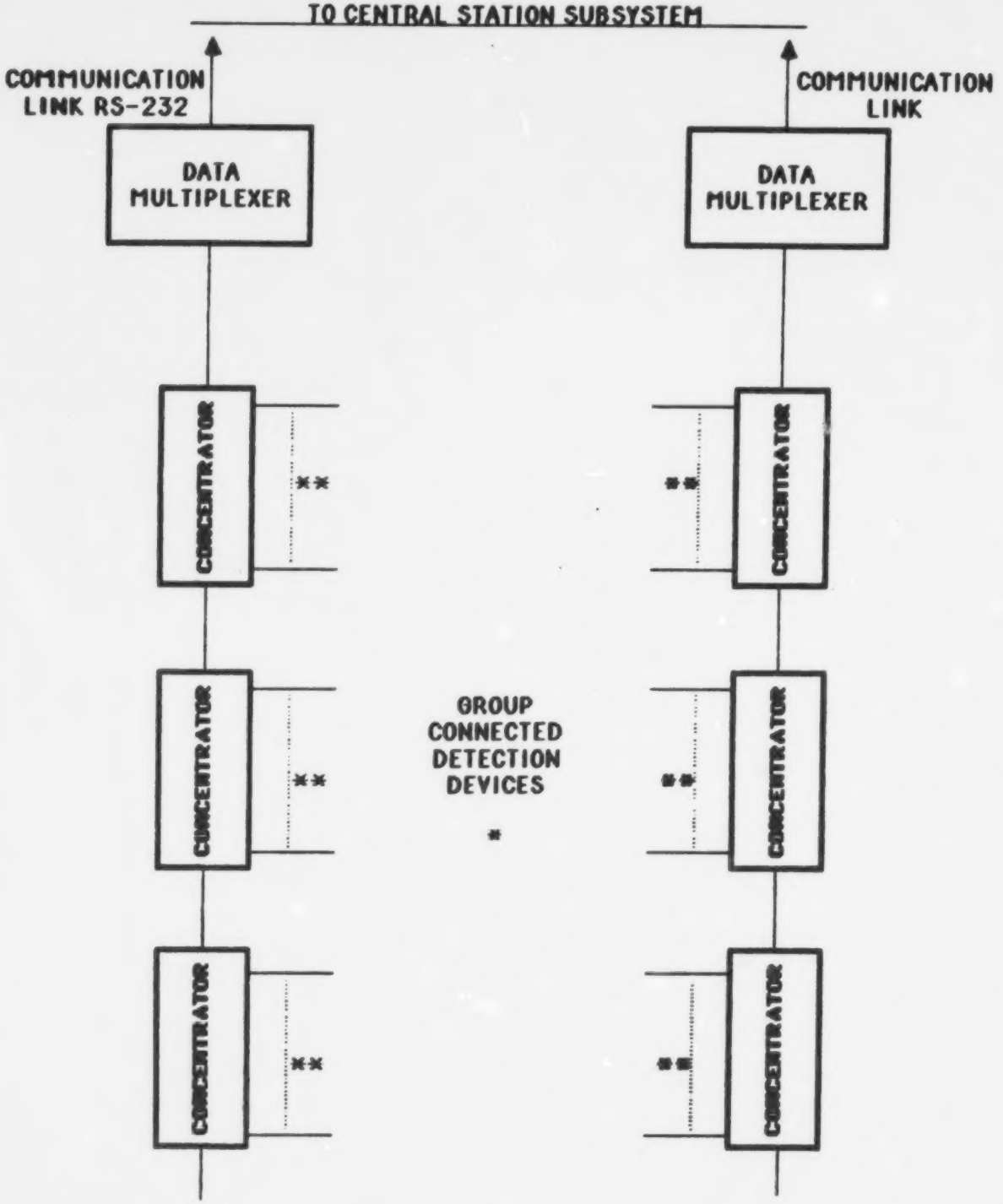
Depending on the airport size and the distribution of the detection devices, the signal conditioning subsystem may be located close to the central computer or distributed throughout the building.

A typical centralized system would have concentrators and data multiplexers in the same room, either remote from or close to the central computer. In this case, the link subsystem is relatively large since each detection device has a wire to the "concentrator" room.

A typical distributed system would have the concentrators close to the detection devices, which are then locally group-connected, (this means a relatively short link subsystem); the data multiplexers would be located remote from the central computer (for instance, in an equipment room) or close to it.

Communication links with the central station subsystem would be directly connected with the serial RS-232-C type or through usage a pair of modems/data sets depending upon the distance between the two subsystems.

TYPICAL SIGNAL CONDITIONING SUBSYSTEM CONFIGURATION



* SENSING SUBSYSTEM
** LINK SUBSYSTEM

FIGURE 6

6.4 Design issues

The "transparent" signal conditioning subsystem approach offers the following advantages:

a) The proposed equipment is available "off-the-shelf". Typical devices are documented and described in Appendix C.

b) Interconnectivity is standardized throughout the system.

7. CENTRAL STATION SUBSYSTEM

7.1 Central station equipment

The central station consists of:

a) A dedicated micro-computer or mini-computer, with appropriate memory and software.

b) Appropriate communication interfaces to the signal conditioning subsystem and optional remote stations.

c) Peripheral devices associated with the computer:

- Tape storage media (back-up).
- Disk storage media.
- Monochrome monitor.
- Keyboard.
- Hardcopy printer.
- Cursor control device (optional).
- Modem (optional).

7.2 Application software

7.2.1 General

The application software should basically consist of:

a) Security and password access.
b) Polling and communications.
c) Display interface.
d) System monitoring and diagnosis.
e) Report generation.
f) Recovery in case of failure.

g) Application calculations.
h) Data base and file organisation.
i) Back-up and archive.

The software implementation should facilitate the operations and the retrieval/entry of information by personnel untrained in computer operations.

Access to any function must not interrupt the normal process of data acquisition. The exception to this is the data base reorganization function, which should be implemented in a way as to minimize the data acquisition down-time.

Figure 7 shows a hierarchical functional chart.

7.2.2 Menus

a) Main Menu

When the system is started, a menu is presented to the user with the following choices:

- Maintenance sub-menu.
- Data acquisition sub-menu.
- Report sub-menu.
- Data base management sub-menu.
- Display control.

The user should select one function, and control will be passed to the appropriate program.

FUNCTIONAL SPECIFICATIONS OF PROPOSED SYSTEM

HIERARCHICAL FUNCTIONAL CHART

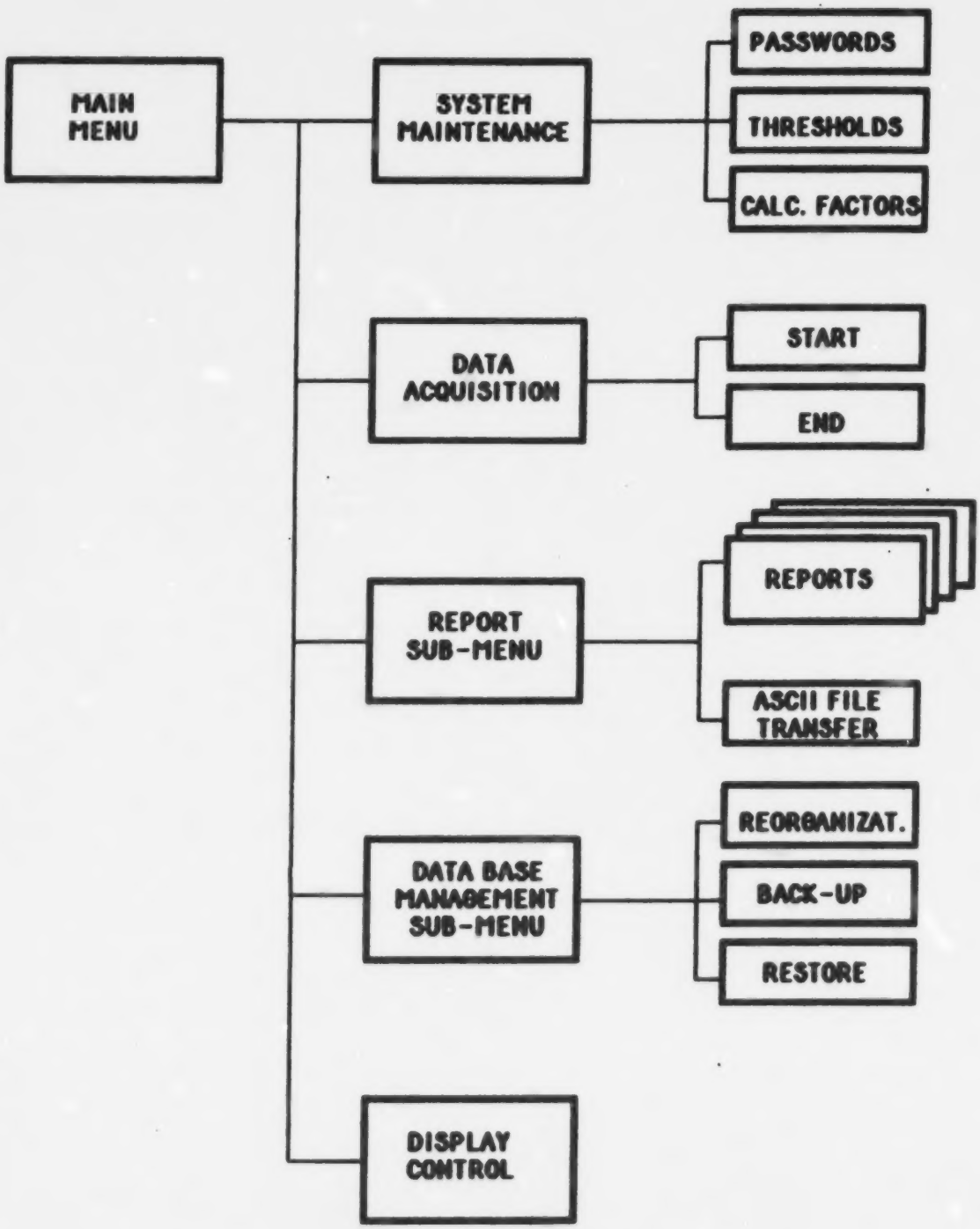


FIGURE 7

b) Maintenance sub-menu

The following functions will be indicated in this sub-menu:

- Password addition/modification control.
- Modification of a correction factor that may be applied to any detection device.
- Addition, modification and deletion of thresholds.

This sub-menu is only accessible to the user on a password protection basis.

c) Data acquisition sub-menu

This function should start or end the data acquisition process.

d) Report sub-menu

This function should permit the selection of a variety of standard reports related to central station functions and capabilities, including (but not limited to): the number of airport users (per category), listings, calculations and associated parameters, monitoring.

e) Data base management sub-menu

This function should permit the choice of one of three following options:

- Reorganize the database currently in place.
- Make an archive back-up of the database, or part of the data base.
- Restore the database from the last archive copy.

This sub-menu can only be accessed through password identification.

f) Display control

The operator can specify which screen layout should be displayed on a continuous basis.

7.3 Hardware design guidelines

7.3.1 Off-the-Shelf

All the components used in the counting/tracking system shall be standard "off-the-shelf" wherever possible.

7.3.2 Proven design

Equipment is to be of a proven design. Any custom made equipment or software specially designed for this system should be so mentioned and completely documented for proper use.

7.3.3 Modularity

The system should be modular in design; in this approach, modifications or add-ons should allow the remaining elements of the system to function properly.

7.3.4 Reliability

The system should be designed so as to provide maximum availability. Calibration and changes of devices shall be possible without interrupting the counting process.

Repair time shall be minimized by means of standardization of spare devices and modularity of other components (link and signal conditioning subsystems).

7.3.5 Good Installation Practice

Wiring cabling, interconnections of equipment and installation procedures should be performed according to good practices. This includes standard and consistent wire color coding, proper shielding and grounding.

7.4 Software design guidelines

7.4.1 Software Implementation

The software implementation should be of a "user friendly" type, providing maximum clarity and operational efficiency with minimal need for reference to the user's manual by operators who do not possess programming knowledge. The man-machine interfaces

should be bilingual, that is, language selectable by the operator, French or English.

7.4.2 Operating System

The operating system should be of an industry accepted type such as MS/DOS, OS/2, VMS or a standardized version of UNIX.

7.4.3 Data Storage

The data will be stored using a DBMS or file organization with a wide user base (i.e.: ORACLE, INFORMIX, DBASE or RBASE, etc.).

7.5 Expandability and growth capability

The system should be capable of expansion and growth according to the levels described in section 2.2. It should be expandable and fully operational from "passengers only" level up to the "additional capabilities" level without any major modifications at the central station (hardware and software), at the signal conditioning subsystem and at the existing counting thresholds.

The addition of counting thresholds should not require additional interface equipment at the central station.

7.6 Documentation

The documentation should describe, in detail, all the functions and capabilities of the system. This should include the menu screens, the correction and correlation functions and the procedures to modify them.

User documentation should be in both official languages.

System documentation may be provided in any one of the two languages and should include, but not be limited to:

- program listings;
- system flow charts and/or data flow diagrams;
- configuration set-up, link and execute procedures;
- data dictionary;
- file organization and description.

7.7 Location

The central station equipment should be located in a room within the airport, as determined by AAG.

8. BASIC COST CONSIDERATIONS

8.1 Assumptions

In order to evaluate the cost of implementing a counting system in various Canadian airports, the following assumptions were made:

a) The central station subsystem may be a PC-286 type or a Microvax II, depending on the number of thresholds and their inherent characteristics (NOW, WOW, etc.).

b) The equipment used as detection devices, link and signal conditioning subsystems is standardized for the cost evaluation, whatever the size of the airport.

c) Some development costs for the custom software interface may be shared if more than one site is implemented with a similar computer configuration or if a site is upgraded by the addition of detection devices.

d) Project management estimation is based on the following:

- For the estimated duration of the project: the equivalent of a project manager at 20% of his time.

- For the initiation of the project and the coordination of the acceptance testing to be conducted by the elected suppliers: full time, between 6 to 18 weeks depending on the scope of the project (test, pilot or complete).

Tables 3, 4 and 5 present the number of thresholds and the corresponding quantities of detection devices for the Dorval, Thunder Bay and Ste-Foy airports.

TABLE 3: DORVAL AIRPORT: NUMBER OF THRESHOLDS AND REQUIRED NUMBER OF EMITTER/RECEIVER SETS

		TYPES OF THRESHOLD					
		ONE-WAY			TWO-WAY		
		ONE-PERSON		TWO-PERSON	ONE-PERSON		TWO-PERSON
THRESHOLD LOCATION		HORIZONTAL BEAM	OVERHEAD BEAM		HORIZONTAL BEAM	OVERHEAD BEAM	
DEPARTURE LEVEL	DOMESTIC SECTOR	—	—	—	3	—	—
	TRANSBORDER SECTOR	2	—	—	—	1 (1)	1 (1)
ARRIVAL LEVEL	DOMESTIC SECTOR	—	—	2	—	—	—
	TRANSBORDER SECTOR	2	—	—	—	—	—
GENERAL PUBLIC DOORS	DEPARTURE LEVEL	—	—	8	—	—	4
	ARRIVAL LEVEL	—	—	9	4	—	4
TOTAL NUMBER OF THRESHOLDS		4	0	19	7	1	9
NUMBER OF EMITTER/RECEIVER SETS PER THRESHOLD		1	1	3	2	2	6
TOTAL NUMBER OF EMITTER/RECEIVER SETS: 131		4	0	57	14	2	54

NOTE 1: DOORS DEDICATED TO DOMESTIC CITY EXPRESS FLIGHTS.

NOTE 2: GATES (APPROXIMATELY 180 EMITTER/RECEIVER SETS) ARE NOT CONSIDERED BECAUSE THEY ARE VERY NUMEROUS AND REDUNDANT WITH THE BASIC SYSTEM.

TABLE 4: THUNDER BAY AIRPORT: NUMBER OF THRESHOLDS AND REQUIRED NUMBER OF EMITTER/RECEIVER SETS

		TYPES OF THRESHOLD					
		ONE-WAY			TWO-WAY		
		ONE-PERSON		TWO-PERSON	ONE-PERSON		TWO-PERSON
THRESHOLD LOCATION		HORIZONTAL BEAM	OVERHEAD BEAM		HORIZONTAL BEAM	OVERHEAD BEAM	
DEPARTURE SECTION	SCREENED	—	—	—	1 (1)	—	—
	UNSCREENED	1	—	—	—	—	—
ARRIVAL LEVEL	DOMESTIC	1	—	—	—	—	1
	TRANSBORDER INTERNAT.	—	—	—	—	—	1
GENERAL PUBLIC DOORS		—	—	2	—	—	1
TOTAL NUMBER OF THRESHOLDS		2	—	2	1	—	3
NUMBER OF EMITTER/RECEIVER SETS PER THRESHOLD		1	1	3	2	2	6
TOTAL NUMBER OF EMITTER/RECEIVER SETS: 28		2	0	6	2	0	18

NOTE 1: LOCATED AT THE DETECTOR LOOP INSTEAD OF DEPARTURE GATE.

NOTE 2: AT THUNDERBAY AIRPORT, STAND-ALONE DETECTORS ALREADY EXIST BUT THEY SHOW INADEQUATE RESPONSIVENESS AND ARE NOT INTEGRATED IN A NETWORK.

TABLE 5: STE-FOY AIRPORT: NUMBER OF THRESHOLDS AND REQUIRED NUMBER OF EMITTER/RECEIVER SETS

		TYPES OF THRESHOLD					
		ONE-WAY			TWO-WAY		
		ONE-PERSON		TWO-PERSON	ONE-PERSON		TWO-PERSON
THRESHOLD LOCATION		HORIZONTAL BEAM	OVERHEAD BEAM		HORIZONTAL BEAM	OVERHEAD BEAM	
DEPARTURE SECTION	SCREENED	—	—	—	2+5 (1)	—	1 (2)
	UNSCREENED	—	—	—	2	—	—
ARRIVAL LEVEL	DOMESTIC	—	—	1	—	—	—
	TRANSBORDER INTERNAT.	2	—	—	—	—	—
GENERAL PUBLIC DOORS		—	—	—	—	4	5
TOTAL NUMBER OF THRESHOLDS		2	—	1	9	4	6
NUMBER OF EMITTER/RECEIVER SETS PER THRESHOLD		1	1	3	2	2	6
TOTAL NUMBER OF EMITTER/RECEIVER SETS: 67		2	0	3	18	8	36

NOTE 1: 2 FOR THE DETECTOR LOOPS, 5 FOR THE ONE-PERSON GATES; FOR THE GATES, TWO-WAY THRESHOLD IS CONSIDERED TO TAKE INTO ACCOUNT THE BOARDING AND THE AIRPORT OPERATIONAL PERSONNEL.

NOTE 2: DEPARTURE AND ARRIVAL.

8.2 Cost evaluation

The complete and detailed list of equipment used for the evaluation of the various implementation schemes can be found in Appendix C.

Table 6 enumerates some typical relevant equipment and their respective applicabilities.

Table 7 presents the cost evaluation on the basis of the table 3, 4, 5 and 6 for Dorval, Thunder Bay and Ste-Foy airports.

8.3 Personnel requirements

At the implementation stage, the detection/counting/tracking system would obviously impose an increased load on personnel involved with data gathering.

Once people are familiar with the system, data gathering should be done on a routine basis (screen monitoring and report printing) easily absorbed through actual personnel work load.

8.4 Validation procedure

The counting thresholds supplied by the eventual contractor should perform adequately as per the required performance from the request for proposal document. Nevertheless, a validation procedure of the detection/counting system is necessary to:

° verify detection/counting performance in actual airport environment;

° establish correction factors as a function of flow density;

° determine particular conditions that may impede proper functioning.

Basically, a validation procedure should be made according to two complementary ways:

1° by comparing the overall counts of the detection/counting system to data obtained from the existing sources (like Statistic Canada) and deduce appropriate overall correction factors;

2° by comparing each threshold counts to manual counts performed by a person who observes people crossing the threshold under study.

The first procedure is likely to be done "naturaly" when existing sources would provide their results.

The second procedure involves dedicated personnel and must be established with the airport management. A proposed validation procedure is presented:

° one person covering the departure area during one week for each sector;
° one person covering the arrival area during one week for each sector;
° one person covering all the general public doors during two weeks;
° the above mentioned procedure to be repeated three times in the first year and as needed in the subsequent years.

The associated estimated costs would be approximately $ 10 000 for the first year. They are not included in the overall project costs.

TABLE 6: EQUIPMENT BREAKDOWN AND MODULARITY

SUBSYSTEM		DESCRIPTION	MODULARITY	BUDGETARY UNIT COST ($)
SENSING		Infra-red emitter/ receiver set: detection device.	Depends on thresh-old configuration (see table 2).	200
LINK		Hardwire (twisted pair).	One link for each emitter/receiver set to a concen-trator.	Depends on length and airport en-vironment.
SIGNAL CONDITIONING		Concentrator, typical: MI-6 from Slage.	Can handle up to six (6) detection devices	800
		Data multiplexer, typical: 902 from Slage.	Can handle up to eight (8) concen-trators (total: 48 detection devices) Up to two (2) per PC.	2 500
		Hardwire (twisted pair)	One link to connect eight (8) concentrators to a data multiplexer.	Depends on length and airport environment.
		Limited distance data set (if required, because of distance).	Two per data mul-tiplexer line.	100
CENTRAL STATION	OPTION 1	PC-286	If less than 96 detection devices.	10 000
	OPTION 2	MV-II	If more than 96 detection devices.	50 000

TABLE 7: COST EVALUATION FOR DETECTION/COUNTING SYSTEM IMPLEMENTATION

DESCRIPTION	AIRPORTS					
	DORVAL (NOTE 1)		THUNDER BAY		STE-FOY	
	QTY	$	QTY	$	QTY	$
Detection devices	310	62 000	28	5 600	67	13 400
Slage MI-6	52	41 600	5	4 000	12	9 600
Slage 902	7	17 500	1	2 500	2	5 000
Data sets	14	1 400	2	200	4	400
Power supply (UPS) for Slage 902	2	2 000	1	1 000	1	1 000
PC-286 and peripherals	N/A	N/A	1	10 000	1	10 000
MV-II and peripherals	1	50 000	N/A	N/A	N/A	N/A
Power supply (UPS) for computer	1	4 000	1	3 500	1	3 500
Operating system MS-DOS	N/A	N/A	1	100	1	100
Operating system VMS	1	3 000	N/A	N/A	N/A	N/A
Slage 5795A system software	N/A	N/A	1	1 200	1	1 200
C-CURES system software	1	19 000	N/A	N/A	N/A	N/A
Custom interface	1	15 000	1	15 000	1	15 000
Cabling & connectors	-	5 000	-	700	-	1 000
SUB-TOTAL EQUIPMENT	220 500		43 800		60 200	
Installation	25 000		3 000		6 000	
Provincial sales tax: 9%	19 900		4 000		5 400	
Project management	60 000		25 000		30 000	
SUB-TOTAL	325 400		75 800		101 600	
Contingency plan: 10%	32 500		7 600		10 400	
TOTAL	357 900		83 400		112 000	

Note 1: Full blown system comprising all the gates at Dorval. The recommended test and pilot projects exclude gates as described in table 8.

9. PROPOSED APPLICATIONS FOR DORVAL AIRPORT

Following our investigation and analysis of the different components required to properly count airport users, and due to the peculiar characteristics of the environment at a given airport, it is suggested that a test project be conducted prior to a complete pilot project.

We define a "pilot project" as the installation of the required equipment in a target airport to count airport users at all strategic thresholds, namely the security, arrival and general public doors in view of validating the methodology implemented to obtain the airport user count statistics.

The gates were not considered in the pilot project: gate counting is more on less redundant to security and arrival threshold global counting and, consequently, its actual relevance would not likely justify the high costs involved.

Due to the high investment in such a pilot project, if a target airport possesses numerous thresholds, the alternatives to minimize risks and to maximize the potential benefits of such a project are:

a) Either choose a smaller (low number of thresholds) airport as Thunder Bay.

b) Or implement counting at only few selected and critical thresholds in the target airport, in order to validate counting assumptions and methodology.

The second alternative will minimize the required investments and permit a faster implementation. This alternative is defined as the "test project".

TABLE 8: EQUIPMENT COST EVALUATION, TEST, PILOT AND COMPLETE PROJECT AT DORVAL AIRPORT

DESCRIPTION	PROJECT					
	TEST		PILOT		COMPLETE (NOTE 1)	
	QTY	$	QTY	$	QTY	$
Detection devices	48	9 600	131	26 200	310	62 000
Slage MI-6	8	6 400	22	17 600	52	41 600
Slage 902	1	2 500	3	7 500	7	17 500
Data sets	2	200	6	600	14	1 400
Power supply (UPS) for Slage 902	1	1 000	2	2 000	2	2 000
PC-286 and peripherals	1	10 000	N/A	N/A	N/A	N/A
MV-II and peripherals	N/A	N/A	1	50 000	1	50 000
Power supply (UPS) for computer	1	3 500	1	4 000	1	4 000
Operating system MS-DOS	1	100	N/A	N/A	N/A	N/A
Operating system VMS	N/A	N/A	1	3 000	1	3 000
Slage 5795A system software	1	1 200	N/A	N/A	N/A	N/A
C-CURES system software	N/A	N/A	1	19 000	1	19 000
Custom interface (software implementation)	1	15 000	1	15 000	1	15 000
Cabling & connectors	-	1 000	-	3 000	-	5 000
SUB-TOTAL EQUIPMENT	50 500		147 900		220 500	

TABLE 9: PROJECT COST EVALUATION, TEST, PILOT AND COMPLETE PROJECT AT DORVAL AIRPORT

DESCRIPTION	PROJECT					
	TEST		PILOT		COMPLETE (NOTE 1)	
	QTY	$	QTY	$	QTY	$
SUB-TOTAL EQUIPMENT	50 500		147 900		220 500	
Installation	5 000		15 000		25 000	
Provincial sales tax: 9%	4 600		13 300		19 900	
Project management	30 000		40 000		60 000	
SUB-TOTAL	90 100		216 200		325 400	
Contingency plan: 10%	9 000		21 600		32 500	
TOTAL	99 100		237 800		357 900	
APPLICABLE CREDIT FOR A GRADUAL IMPLEMENTATION	N/A		40 000		150 000	
NET TOTAL	99 100		197 800		207 900	
CUMULATIVE GRADUAL IMPLEMENTATION TOTAL	99 100		296 900		504 800	

Note 1: Same column as shown on Table 7, for comparison purposes.

Table 9 presents the corresponding cost evaluation for the test and pilot projects at Dorval, as well as the applicable credits for gradual implementation at the same airport.

Some suppliers are offering to participate in the test project for Dorval by renting the necessary equipment for a given period. With such an option all validation and analysis could be performed prior to the pilot project implementation.

At this stage no firm negotiations have been conducted with these suppliers, but based on the information received, it is understood that:

- equipment that can be recovered and used in another airport may be rented as such;

- installation costs and all other irrecuperable investments will be imbedded in the renting fees or charged separately.

Appendice C gives basic information for test/pilot implementation as it can be applied to Dorval airport:

a) Preliminary list of equipment.

b) Suggested system architecture (Figure C-1).

c) Documentation on suggested equipement.

10. GENERAL CONCLUSIONS

In order to translate the overall objectives of Transport Canada into a comprehensive set of functional and operational requirements for a passenger counting and detection system suitable for both regional and international airports across the country, we have conducted several interviews with representatives of operation management during our visits to four typical airports: Dorval, Thunder Bay, Toronto (Terminals 1 and 2) and Quebec City.

Thunder Bay airport was found to have already a detection/counting system based on infra-red detection technology. However, this system is not networked (the detection devices are stand-alone and require manual data acquisition), and the threshold configurations lack responsiveness, leading to unreliable counts.

Our survey of current system offerings from potential Canadian and foreign suppliers to meet the previously defined requirements was not very successful. None of the contacted firms, selected for their system integration capabilities among representative members of either the electronic sensing and security industry, was in position to offer a complete off-the-shelf system for passenger counting in airports. Moreover, no foreign response was obtained in spite of attempted contacts.

The responses received from the industry confirm the availability of a full range of proven technologies to meet the specific requirements attached to sensing devices, data communication equipments, display and processing units. These responses were used asbasis for a technological study. The conclusion was that active infra-red was the most appropriate technology for detection/counting as per the user requirements.

An overall system approach is suitable to meet the overall system objectives in most airports. This approach is based on a modular design of four standardized subsystems, the implementation of which is to be customized for each individual airport.

Nevertheless, the physical installation of counting thresholds will in fact require a custom design in most cases and subsequent experimentation for the definition of calibration factors to translate detections into actual counts.

At this stage, accurate cost estimates are almost impossible to prepare without a closer look into local constraints and installation conditions. However, budgetary cost estimates have been developed based on unit prices obtained from suppliers.

These budgetary cost estimates include equipment, labour and project management, and are as follows:

Dorval (Montreal), as a test project to validate counting assumptions and methodology: $ 99 100.

Dorval (Montreal), as a pilot project (excluding the gates) and following a test project: $ 296 900.

Dorval (Montreal), complete and direct implementation (including the gates) following a pilot project: $ 357 900.

Thunder Bay, without considering the existing detection/counting system: $ 83 400.

Ste-Foy (Quebec): $ 112 000.

11. RECOMMENDATIONS

In order to validate the proposed concept and assess the feasibility of the selected technologies, we recommend a progressive implementation strategy in three steps:

11.1 First step: test project

This will include a limited number of detection devices installed as follows:

a) Departure

- 3 domestic detector loops (horizontal beam, 6 devices).
- 2 customs check counters, transborder sector (horizontal beam, 2 devices)
- 2 City Express doors (overhead beams, 8 devices).

b) Arrival

- 2 sliding doors, arrival domestic (overhead beams, 6 devices).
- 2 checks gates following the baggage claims, transborder sector (horizontal beams, 2 devices).

This phase should permit the verification of threshold performances and the testing of basic control software after the operation of a total of 24 detection devices. First-level counting is then covered by counting all the passengers.

11.2 Second step: test project

Once the first phase performs satisfactorily, we suggest extending the installation of detection devices to eight adjacent doors at the departure area: four on domestic side and four on transborder side. This will upgrade the system by including some general public circulation and allowing for performance verification of these critical thresholds. This phase adds 24 (overhead beam, 3 per door) more detection devices and fully loads the PC 286's capabilities.

11.3 Third step: pilot project

Once the two phases of the test project give satisfactory results, the pilot project may be implemented by the installation of detection devices at all remaining general public doors, for a total of 131 detection devices.

This will upgrade the system to the second counting level which is considered the minimum operational capabilities.

The pilot project excludes all gates necessary to cover all people flows within the airports.

11.4 Complete project

The decision to proceed with the implementation of the complete system (which includes all the gates) should be based upon a critical analysis of data gathered with the pilot project in order to justify any additional expenditures.

11.5 Proposed implementation

The proposed implementation at Dorval airport of a pilot target user counting system could be carried over a period of 18 to 24 months with the projected cost based on a gradual implementation.

Test project, first phase (6 to 8 months):	$ 75 000
Test project, second phase (2 to 4 months):	$ 25 000
Pilot project, including applicable credit from test project (12 months):	$ 300 000

APPENDIX A

CONSIDERATIONS WITH RESPECT TO USING COUNT PROCESSING TO ESTABLISH THE PROFILE OF TARGET USERS

A-1 Counting accuracy

Counting accuracy is related to the difference between counts given by a counting threshold and the actual number of persons who crossed this threshold during a certain period of time.

This accuracy must be statistically precise and reliable.

The technologies considered should give an appropriate accuracy where counting is relatively simple, as at security thresholds. In these cases, the theresholds are relatively narrow and the flow of people relatively light (one-by-one). Threshold types: one-by-one, one or two-way (NOW, NTW). But many thresholds are technologically more critical, due to their width, high density traffic and/or the behaviour of the person crossing them. These include certain arrival thresholds and the general public doors. (Threshold type: more than one, one or two way (WOW, WTW)).

Realistic accuracies are expected to be about 5% in the best case and about 20% in the worst case.

This takes into account correction factors (determined by survey) that compensate in a statistically predictible manner for the difference between the actual number of persons who crossed the threshold and the resultant counts. These factors may be dependant on the type of threshold and the traffic density:

$$C_a = C_t \times (K_t + K'_t \times C_t)$$

Where:

C_a is the corrected count.
C_t is the resultant count (from the detection device).
K_t is a correction factor applicable to a particular threshold.

K'_t is a correction factor dependant on the traffic density and applicable to the same threshold.

A-2 Terminal building users

Eight types of persons are known to circulate in the airport:

1° Enplaning passengers, going through:

- general public doors (in);
- ticket/check-in counters (by sector);
- concessions;
- security check (by sector, if relevant);
- P.I.L., customs, in cases where U.S. provide this facility for transborder flights (like Dorval, Toronto);
- holdroom;
- gate (out).

2° Deplaning passengers, going through:

- gate (in);
- arrival bottleneck;
- P.I.L., baggage claims, customs, in cases of transborder/ international arrivals;
- baggage claims only for domestic arrivals;
- concessions;
- general public doors (out).

Note: Transferring passengers may stay in the sterile area or go in the general public area; this situation must be taken into account at gate and arrival/security thresholds.

3° Escort to enplaning passengers, going through:

- general public doors (in);
- concessions;
- general public doors (out).

4° Escort to deplaning passengers, going through:

- general public doors (in);
- concessions;
- general public doors (out).

5° Visitors, going through:

- general public doors (in);
- concessions;
- general public doors (out).

6° Airport operational personnel (airport employees, police, security, concessions employees, etc.), going through:

- general public doors (in);
- workplace (in the general public area or in the restricted area);
- concessions;
- general public doors (out).

Note: Traffic through service doors ("personnel only") is not considered.

7° Ground transportation personnel (taxis drivers, bus drivers, guides, etc.), going through:

- ° general public doors (in);
- ° general public doors (out).

8° Boarding personnel (pilot, flight attendants, etc.), following about the same path as enplaning and deplaning passengers.

A-3 User profile and counts

On the basis of these eight types of persons, the term "user profile" is defined as follows:

The user profile is the proportion of each of these types in the total population counted at a specific threshold, for a specific period of time.

The user profile at the general public doors comprises the eight types of persons, while the user profile at arrival/security thresholds and gate thresholds is much simpler: almost all passengers, a few airline staff and airport operational personnel.

A hypothetical user profile and associated counts is shown (for illustration purposes only) in Table 1.

The proposed detection/counting system alone cannot determine such a user profile because it can only give total counts.

Nevertheless, correlations between counting thresholds combined with established parameters may lead to some acceptable approximations, as discussed in paragraph A-4.

HYPOTHETICAL USER PROFILE
AND ASSOCIATED COUNTS
FOR ONE HOUR, GENERAL PUBLIC DOORS

PERSONS INVOLVED	IN'S		OUT'S	
	%	COUNTS	%	COUNTS
Enplaning passengers	50	438	0	0
Deplaning passengers	0	0	50	225
Escorts to enplaning	10	88	10	45
Escorts to deplaning	5	44	12	54
Visitors	3	26	0	0
Airport operational personnel	20	175	11	50
Ground transportation personnel	7	61	13	59
Boarding personnel	5	43	4	17
Total	100	875	100	450

TABLE 1

A-4 Analytical approach

The analytical approach described below was developed on the basis of many discussions with AAG and airports representatives. It is mainly oriented to define the basic assumptions and demonstrate that the proposed detection/counting system may, with some limitations, quantify the targeted airport users as requested in the project work statement. This approach is tentative and an optimum approach could be worked out in a subsequent phase of the project. One should note that the mathematical formulas shown are intented to only illustrate the approach and should not be rigorously used for system implementation.

Concerning the eight types of persons involved, it can be stated that:

1° Escorts to enplaning and deplaning passengers, as well as visitors, form the target group from the marketing point of view of the project.

2° Gates and arrival/security thresholds count mainly passengers and a small proportion of boarding personnel. It is assumed that airport operational personnel make a negligible contribution to these counts.

3° An airport internal study should make it possible, on the basis of a specific analytic approach (to be defined by the airport authorities), count and track the airport operation personnel within the building. It is thus assumed that the airport operational personnel behaviour is known for each hour of the day, for each day of the week.

4° Boarding personnel circulating in the airport are assumed to be related to airport activity (that is, the number of passengers). It is also assumed that enplaning and deplaning boarding personnel are equal.

This leads to the following equation:

$$B_n = (D_n + A_n) \times B + B'$$

Where

B_n is the number of estimated boarding persons in the airport during the n^{th} hour.

$(D_n + A_n)$ is an "activity factor "related to the number of departures (D_n) and arrivals (A_n) during the n^{th} hour counted by gate and security/arrival thresholds.

B and B' are parameters established by survey to relate the number of boarding personnel to passengers.

Note: D_n and A_n already include B_n. Therefore, B_n should be calculated in an iterative way for increased precision.

5° Ground transportation personnel are assumed to circulate only in the vicinity of the general public doors, going in and out in a very short period of time. It is also assumed to be related to airport activities as found at the general public doors.

This leads to the following equation:

$$T_n = (PI_n - OI_n + PO_n - OO_n) \times T$$

A-5 Time considerations

The counting places considered (as seen in paragraph 3.3 and figure 1) are:

1° general public exit/entrance doors;
2° security (departure) and arrival bottlenecks;
3° gates.

Triggering of counting thresholds in these places would allow people tracking to be correlated in space. On the other hand, correlation in time is also requested, for determination of the time spent in the airport by each type of person.

In fact, hourly counting can give the total population within the building for the n^{th} hour the day. By comparing hourly population from one hour to the other in relation to the in's and out's, one can determine the approximate time spent in the airport by the users.

This should also apply to the target users. If we know the in's and out's of the target users according to time, we can determine the average time spent in the airport by them.

Nevertheless, it is believed that a survey would be needed to validate these count values.

It should be noted that hourly counting applies to the report functions of the system. But it must be taken into account that airport operations are a continuous process, with many events much shorter than one hour. It is estimated that sampling periods not longer than 15 minutes be performed by the system, to properly "visualise" user behaviour.

Where

PI_n is the total number of people entering the general public doors during the n^{th} hour of the day.

PO_n is the total number of people exiting the general public doors, during the n^{th} hour of the day.

OI_n is the known airport operational personnel coming in during the n^{th} hour of the day.

OO_n is the known airport operational personnel going out during the n^{th} hour of the day.

T is a parameter established by survey to relate ground transportation personnel to the number of persons passing through the general public doors.

Note: Airport operational personnel in's and out's are substracted in determining T_n because this type of person does not influence the ground transportation personnel activity. T_n is mainly related to passengers and boarding personnel. Also, PI_n and PO_n already include T_n, therefore, T_n should be calculated in an iterative way for increased precision.

6° It is assumed that every persons who enter in the airport eventually leaves, thus balancing the in's and the out's after a relatively long period of time (for example: 24 hours, stating that nobody would stay more than 24 hours in the building). Such a statement is used to balance or reset the system periodically in order to prevent any cumulative error.

This leads to the following equation:

$$\sum_{n=1}^{n=24} (PI_n - PO_n + A_n - D_n) = 0$$

Where:

A_n is the total arrival counts during the n^{th} hour of the day.

D_n is the total departure counts during the n^{th} hour of the day.

PI_n and PO_n were defined previously.

7° For short periods of time, any imbalance between in's and out's relates to a total number of persons within the airport buildings, on the basis of the following equation:

$$N_n = N_{n-1} + PI_n - PO_n + A_n - D_n$$

Where:

N_n is the total population during the n^{th} hour of the day within the building.

N_{n-1} is the total population as established in the previous hour within the building.

Other terms were defined previously.

A-6 Number of target users

Target users include:

1° The passengers, enplaning and deplaning, by sector.

2° The escorts (meeters/greeters) of these passengers, and the visitors.

Enplaning passengers are distinctly counted at the security thresholds and gates, by sectors. If we know (by survey) that a counted enplaning passenger triggered the general public doors about one hour before (for example), enplaning passengers can thus be correlated in time with these general public doors.

Accordingly, deplaning passengers are distinctly counted at the arrival thresholds and gates, by sector. If we know (by survey) that a counted deplaning passenger will trigger the general public doors about one half hour later (for example), deplaning passengers can thus be correlated in time with these general public doors.

On the basis of previous discussions, the following types of persons are known and accounted for:

1° enplaning passengers;
2° deplaning passengers;
3° boarding personnel;
4° ground transportation personnel;
5° airport operationel personnel.

Therefore, escorts and visitors can be determined by the following equations:

$$GI_n = PI_n - D_{n+t} - B_{n+t} - T_n - OI_n$$

$$GO_n = PO_n - (A_{n-t}) - (B_{n-t}) - T_n - OO_n$$

Where:

GI_n and GO_n are the estimated number of meeters/greeters/visitors who come in and out respectively during the n^{th} hour of the day.

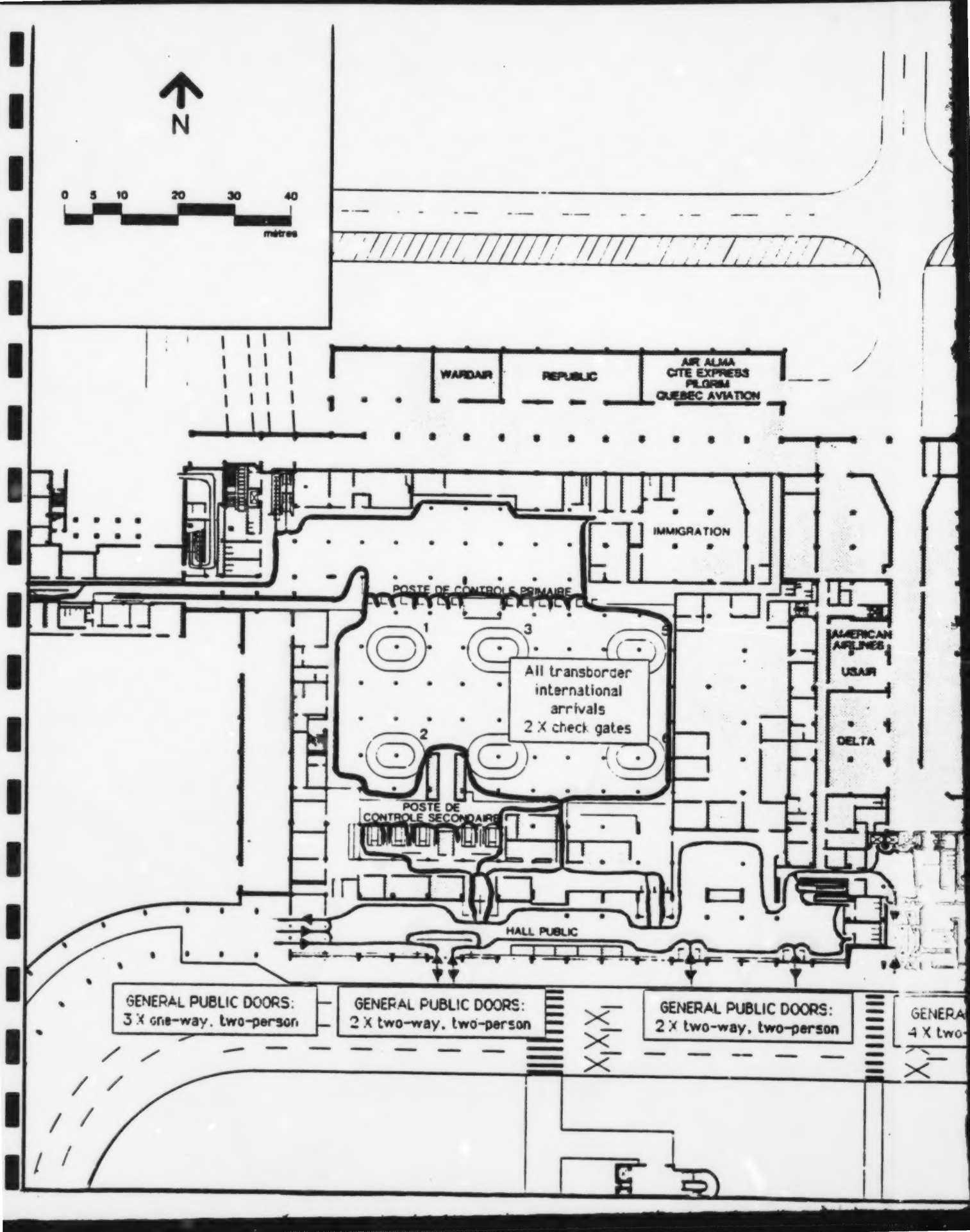
All the other terms were defined previously, taking into account that:

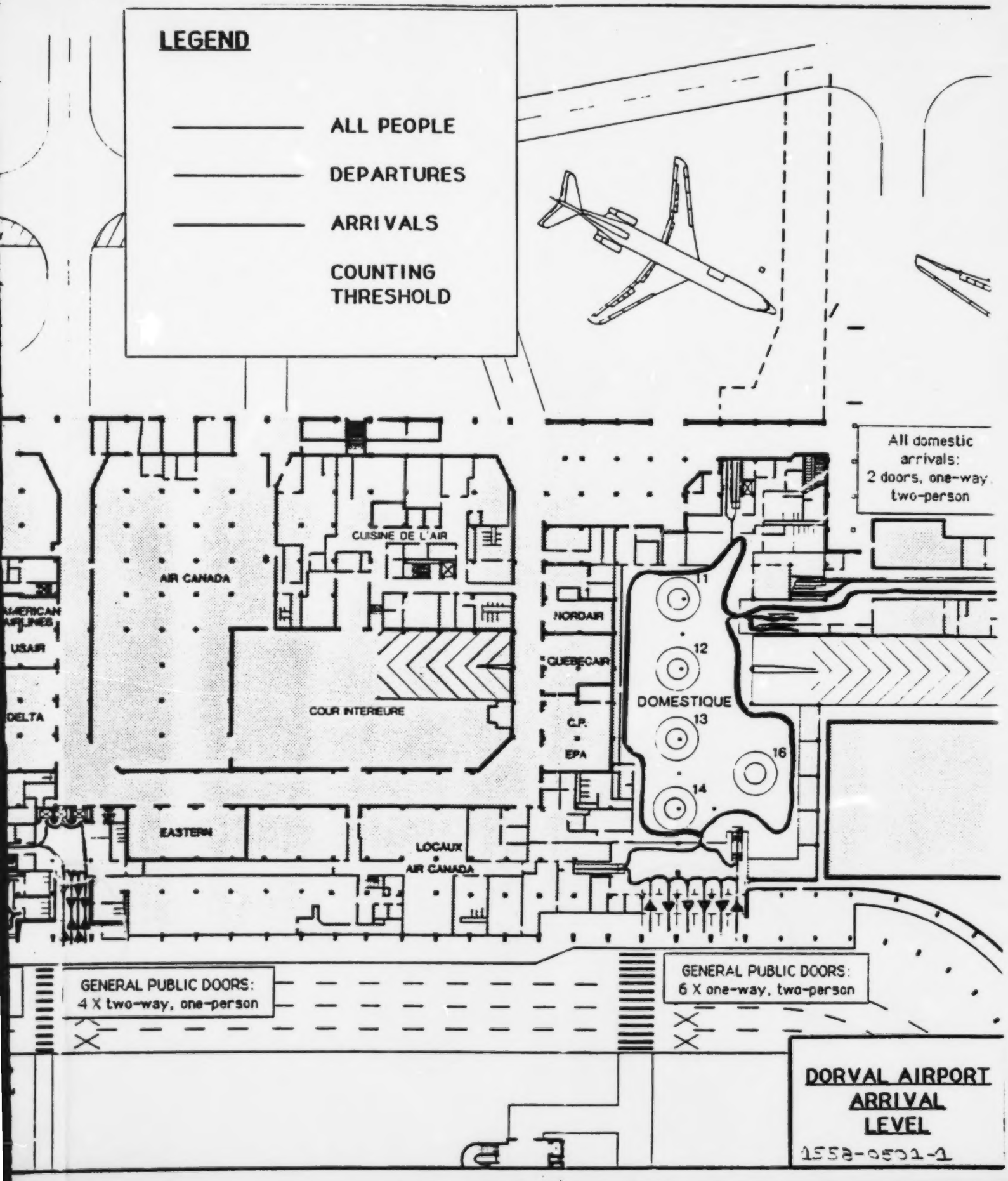
$n+t$ and $n-t$ relate to a delay function that can be established by survey and "visualised" on the basis of a "x" minute sampling period (15 minutes sampling could likely be considered).

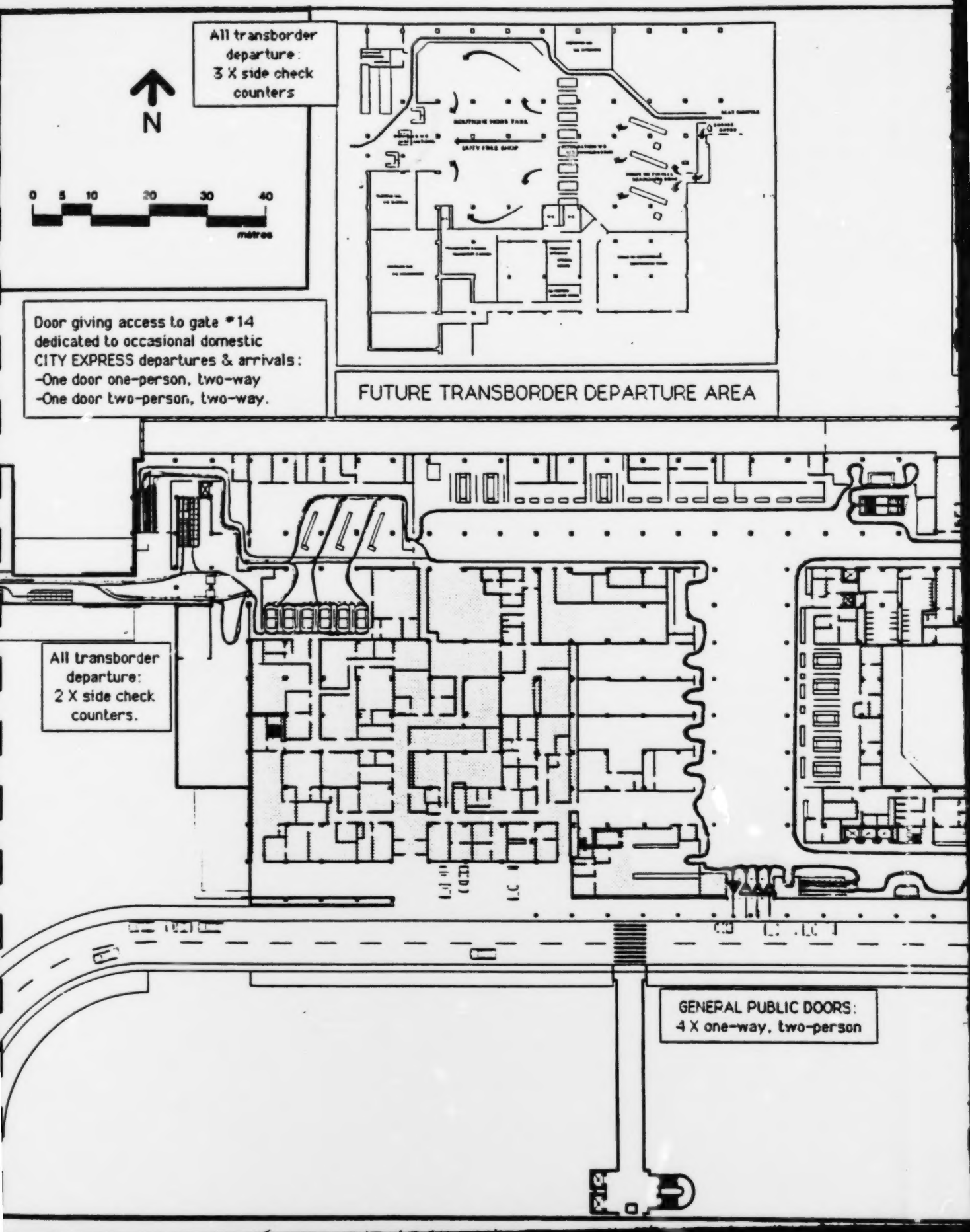
APPENDIX B

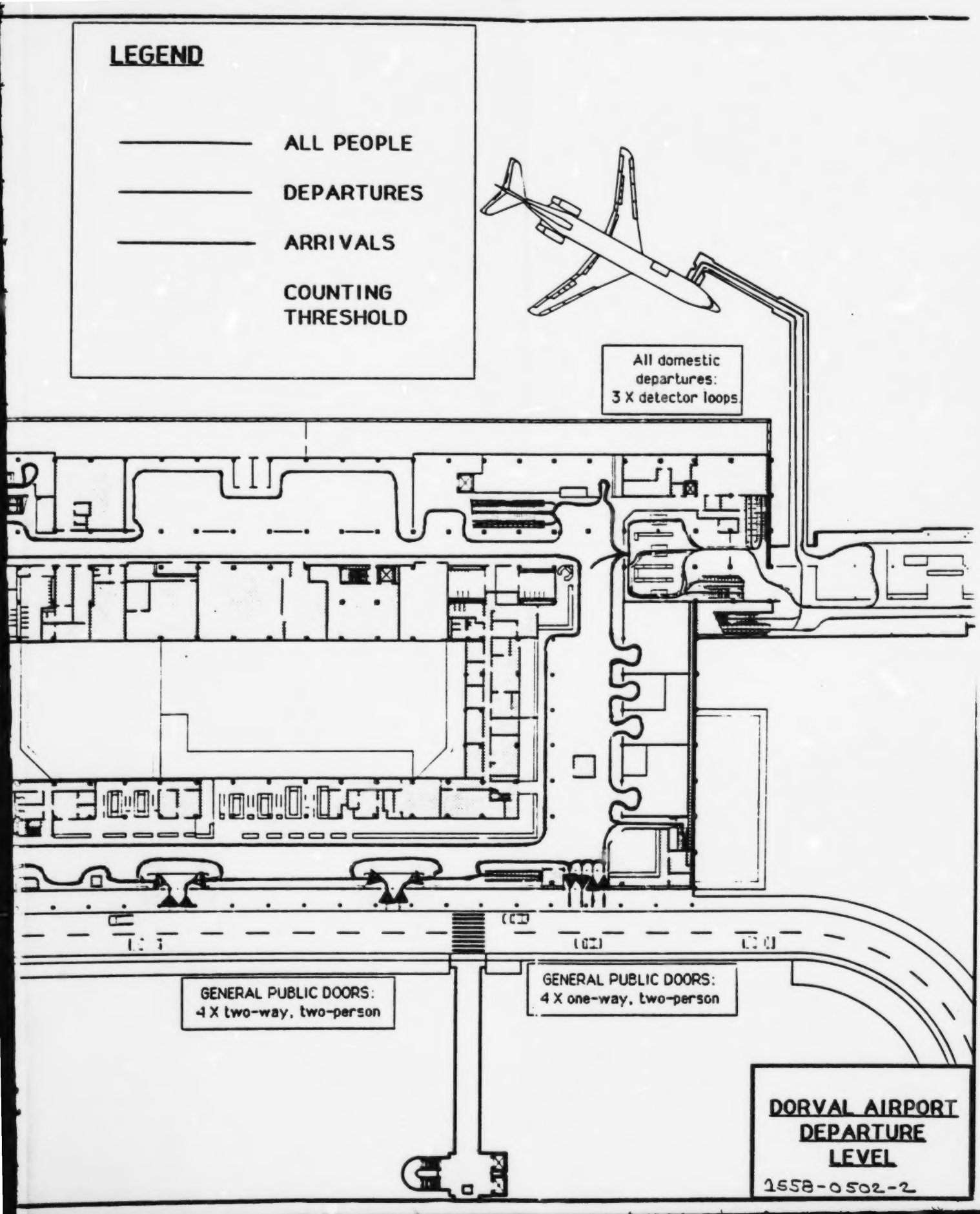
INDICATION OF PEOPLE FLOWS (VISUAL AIDS) RELATED TO: GENERAL PUBLIC, DEPARTURES AND ARRIVALS

- DORVAL (TWO FLOOR PLANS)
- THUNDER-BAY (ONE FLOOR PLAN)
- STE-FOY (TWO FLOOR PLANS)

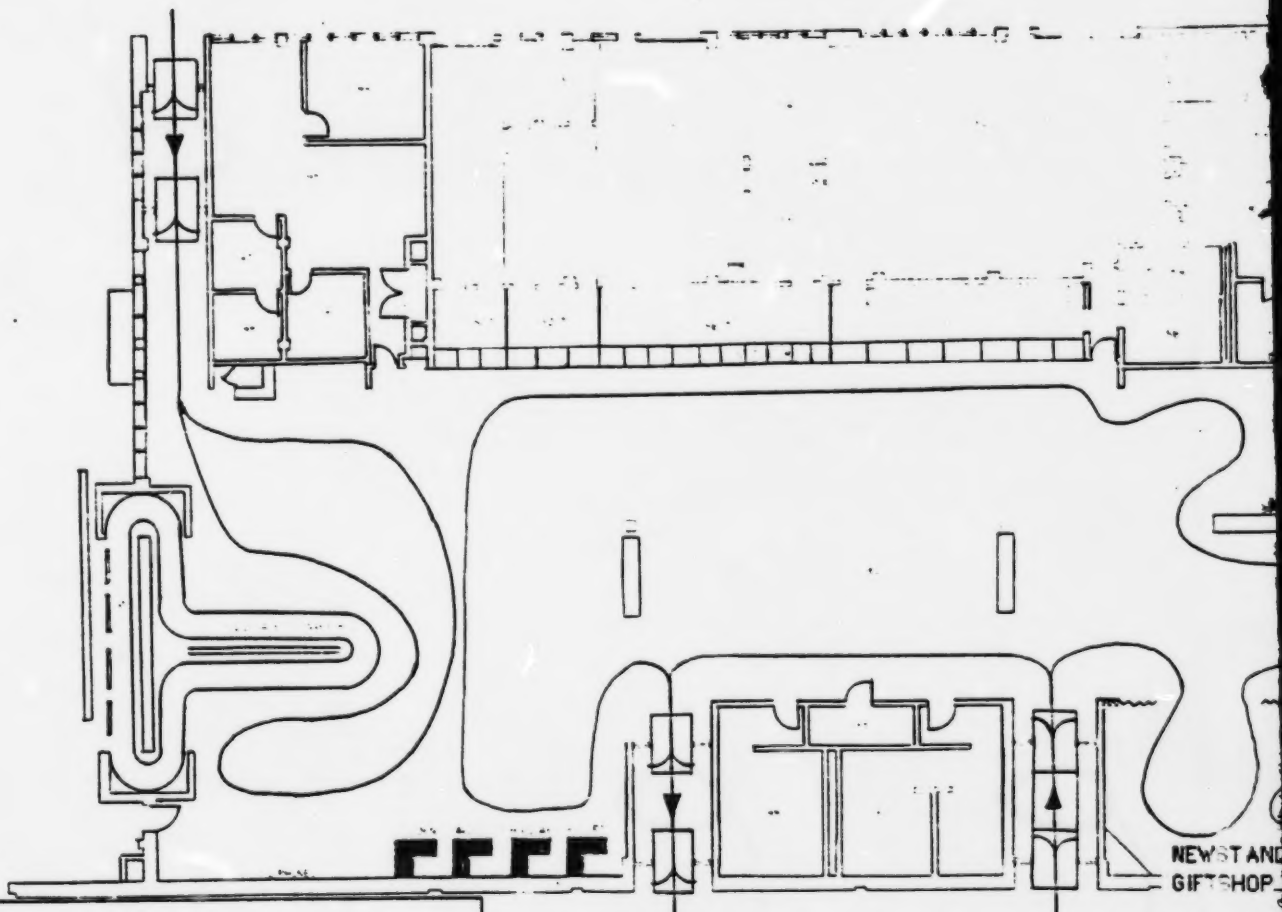

N
0 5 10 20 30 40
mètres
WARDAIR
REPUBLIC
AIR ALMA
CITE EXPRESS
PILGRIM
QUEBEC AVIATION
IMMIGRATION
POSTE DE CONTROLE PRIMAIRE
1
2
3
All transborder international arrivals
2 X check gates
POSTE DE CONTROLE SECONDAIRE
AMERICAN AIRLINES
USAIR
DELTA
HALL PUBLIC
GENERAL PUBLIC DOORS:
3 X one-way, two-person
GENERAL PUBLIC DOORS:
2 X two-way, two-person
GENERAL PUBLIC DOORS:
2 X two-way, two-person
GENERA
4 X two-


LEGEND
ALL PEOPLE
DEPARTURES
ARRIVALS
COUNTING THRESHOLD
All domestic arrivals: 2 doors, one-way, two-person
AIR CANADA
CUISINE DE L'AIR
COUR INTERIEURE
NORDAIR
QUEBECAIR
C.P. EPA
DOMESTIQUE
11
12
13
14
16
USAIR
DELTA
EASTERN
LOCAUX AIR CANADA
GENERAL PUBLIC DOORS: 4 X two-way, one-person
GENERAL PUBLIC DOORS: 6 X one-way, two-person
DORVAL AIRPORT ARRIVAL LEVEL
1558-0501-1


All transborder departure: 3 X side check counters
N
0 5 10 20 30 40
metres
Door giving access to gate #14 dedicated to occasional domestic CITY EXPRESS departures & arrivals:
-One door one-person, two-way
-One door two-person, two-way.
FUTURE TRANSBORDER DEPARTURE AREA
All transborder departure: 2 X side check counters.
GENERAL PUBLIC DOORS: 4 X one-way, two-person


LEGEND
ALL PEOPLE
DEPARTURES
ARRIVALS
COUNTING THRESHOLD
All domestic departures: 3 X detector loops
GENERAL PUBLIC DOORS: 4 X two-way, two-person
GENERAL PUBLIC DOORS: 4 X one-way, two-person
DORVAL AIRPORT DEPARTURE LEVEL
1558-0502-2

DOMESTIC ARRIVALS
1 X two-person, one-way
(See NOTE 2)



GENERAL PUBLIC DOORS:
EXIT,
1 X two-person, one-way

GENERAL PUBLIC DOORS:
ENTRANCE,
1 X two-person, one-way

LEGEND

——— ALL PEOPLE

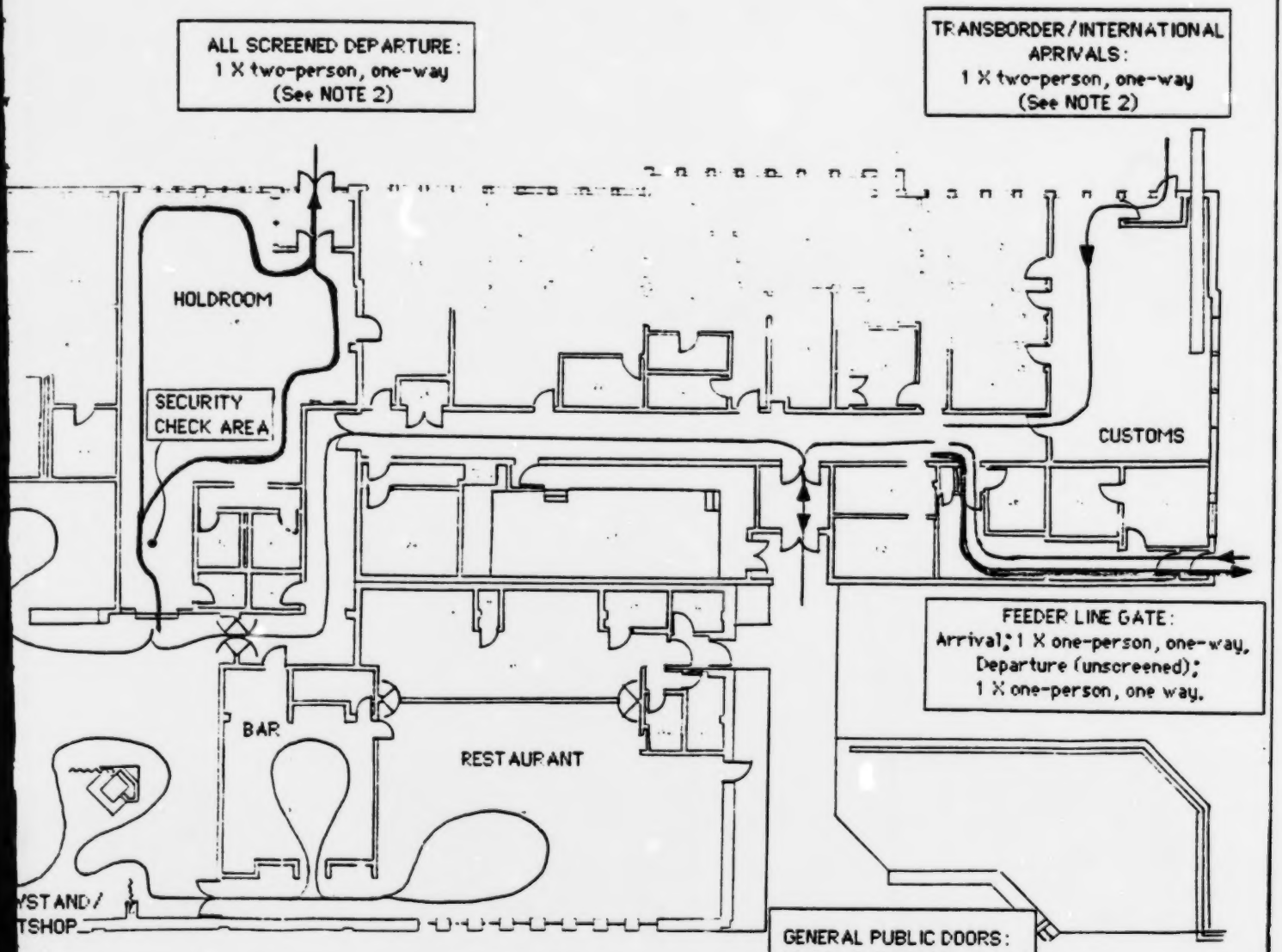
——— DEPARTURES

——— ARRIVALS

EXISTING SINGLE HORIZONTAL BEAM STAND-ALONE COUNTER (SEE NOTE 1)

NOTE 1: The figures of these counters are believed to be distorted because two or more persons may pass simultaneously and also persons may pass in the reverse direction.

NOTE 2: These doors are o
passengers but
tional personnel
circulate in eithe

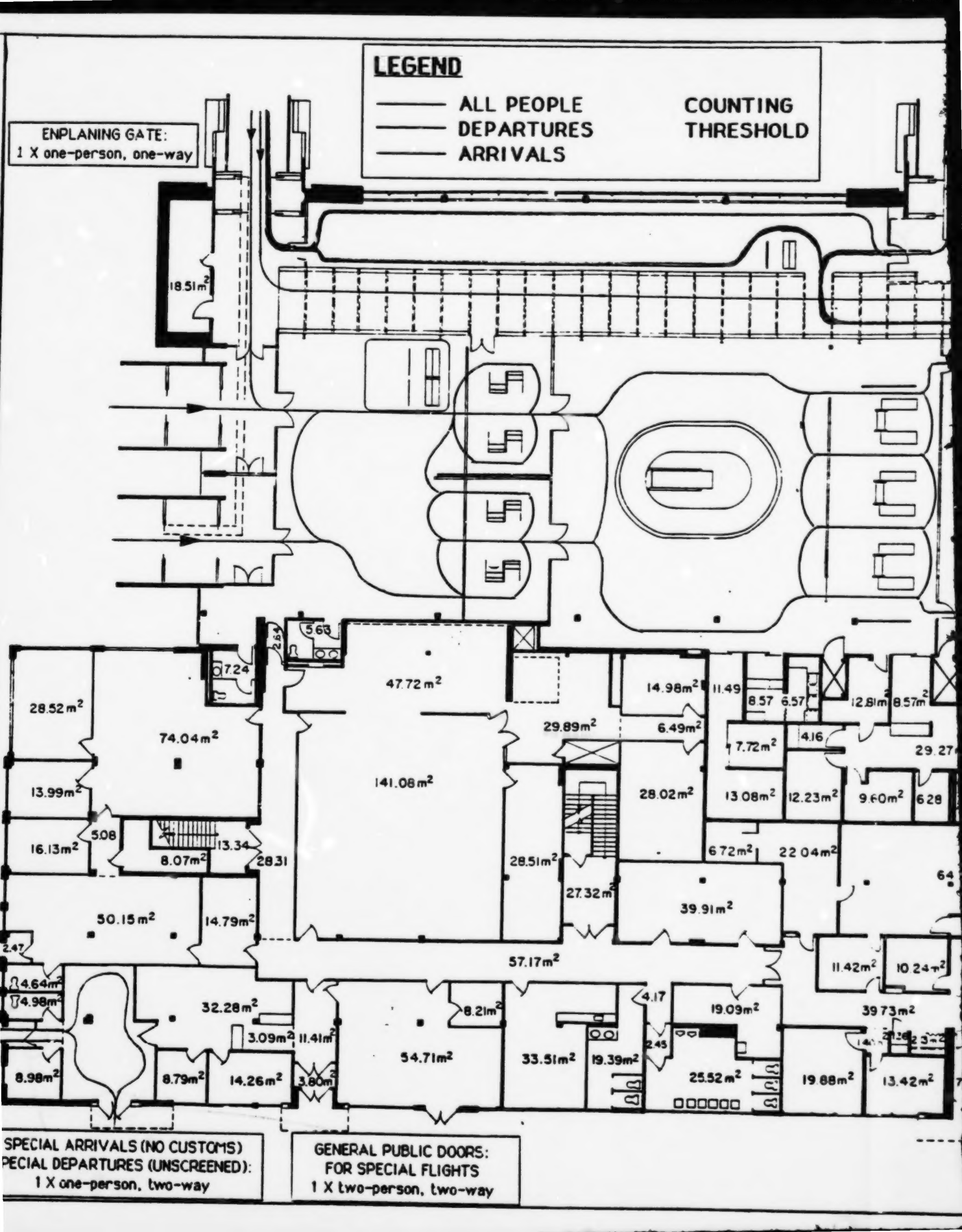


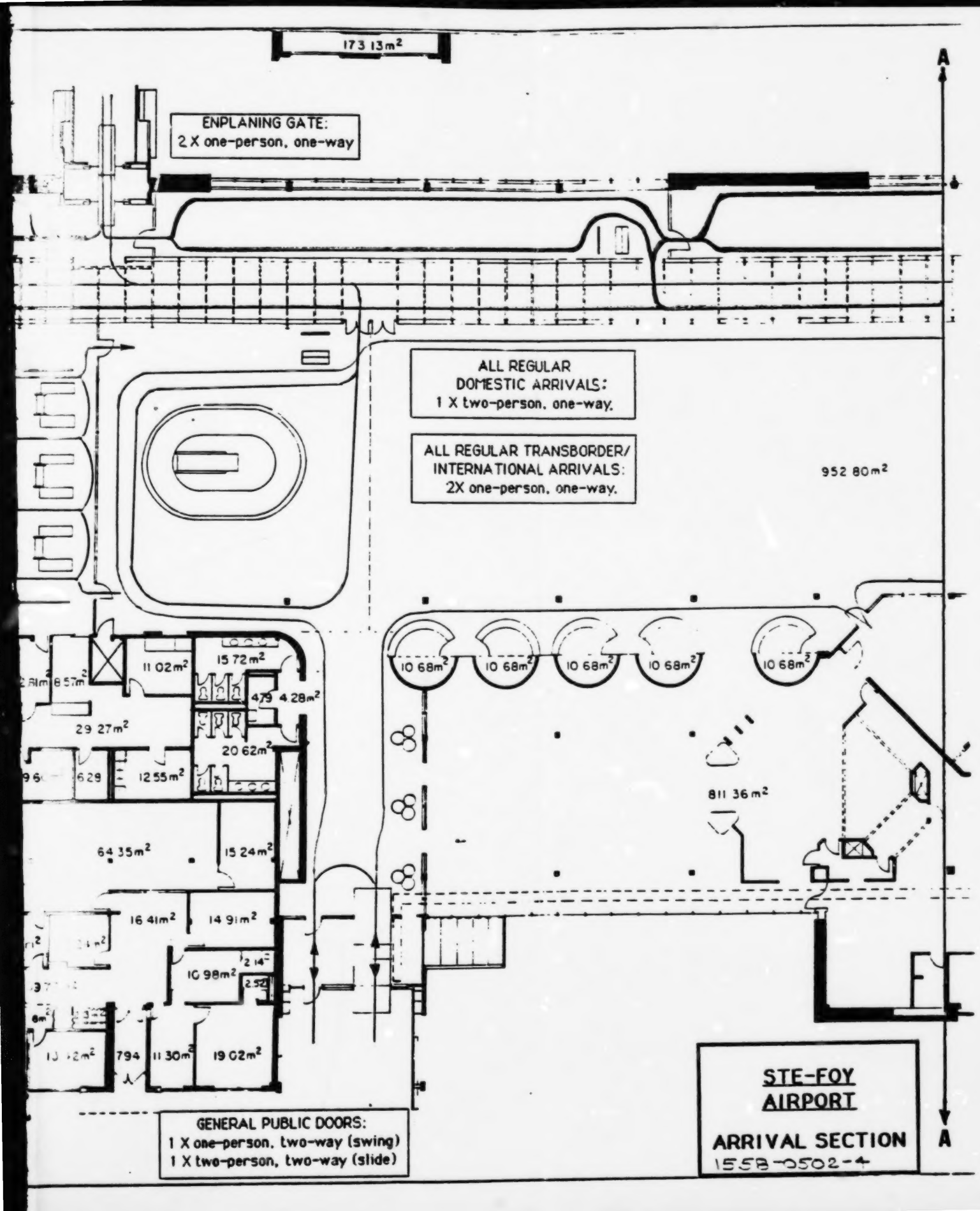
:S:
ray

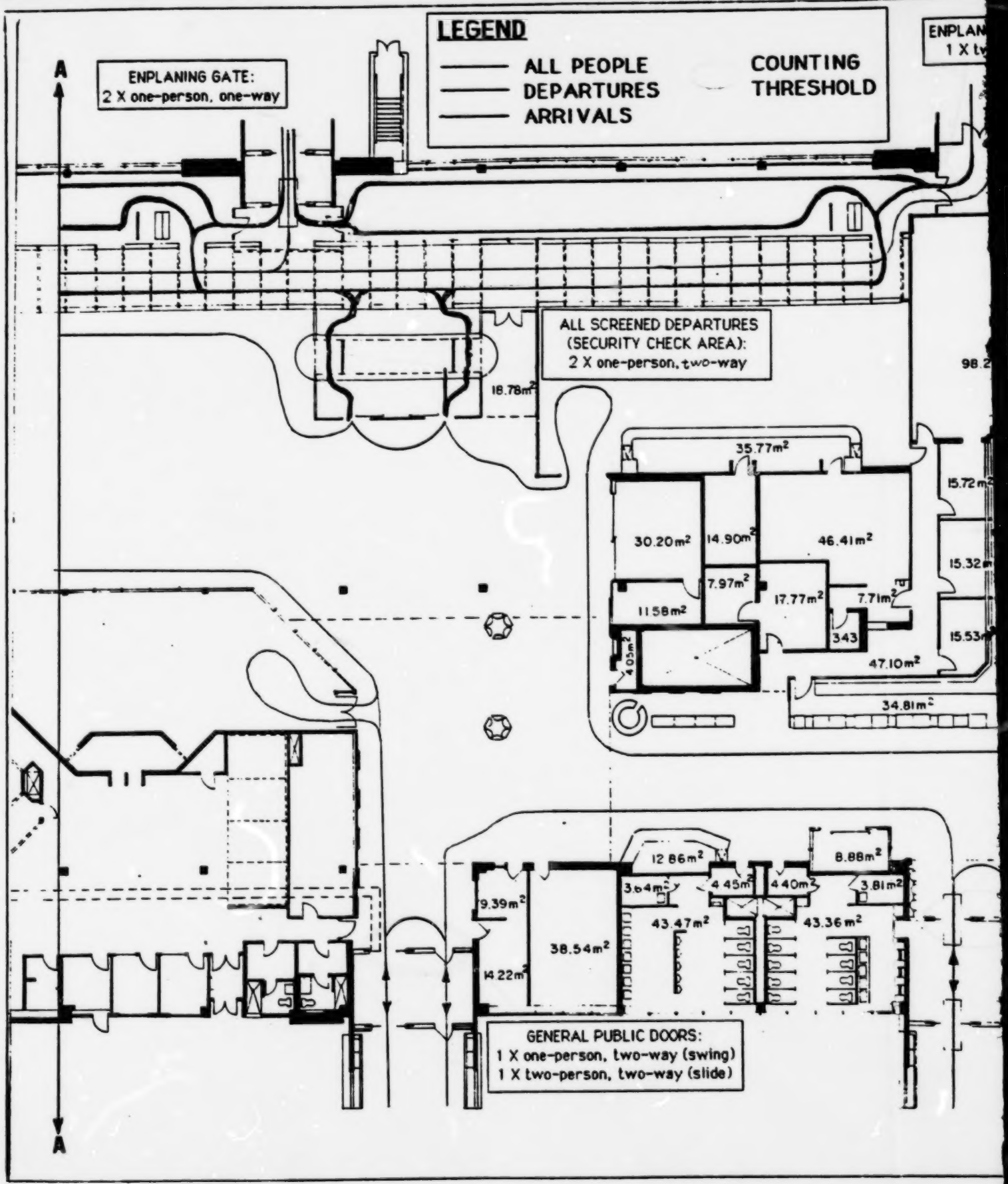
s are one-way for
, but airport opera-
onnel are meant to
either direction.

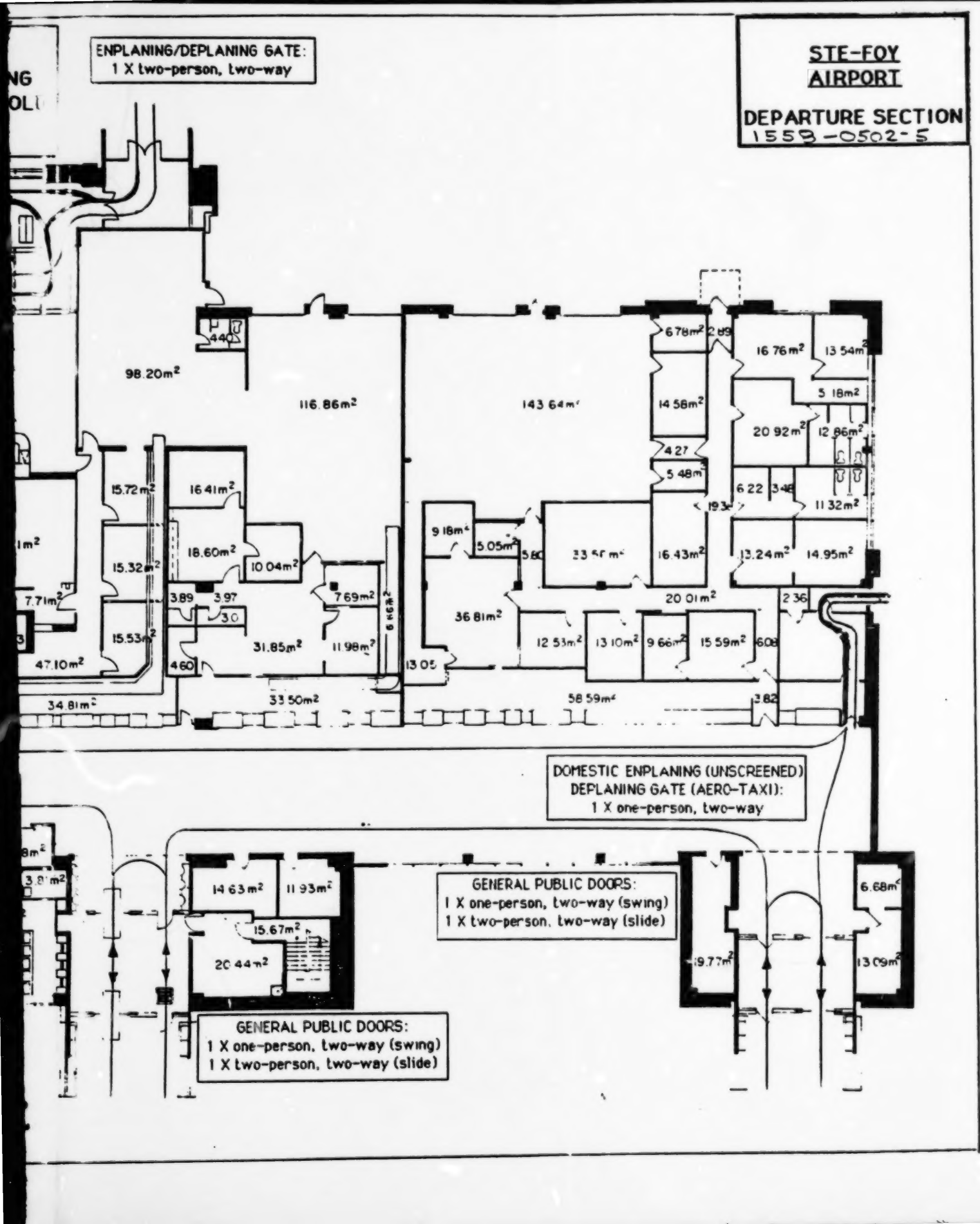
THUNDER BAY AIRPORT

1559-0502-3


LEGEND
ALL PEOPLE
DEPARTURES
ARRIVALS
COUNTING THRESHOLD
ENPLANING GATE:
1 X one-person, one-way
18.51m²
5.63
2.64
7.24
47.72 m²
28.52 m²
74.04m²
14.98m²
11.49
8.57
6.57
12.81m²
8.57m²
29.89m²
6.49m²
7.72m²
4.16
29.27
13.99m²
141.08m²
28.02m²
13.08m²
12.23m²
9.60m²
6.28
16.13m²
5.08
13.34
8.07m²
28.31
28.51m²
6.72m²
22.04m²
27.32m²
39.91m²
50.15m²
14.79m²
2.47
57.17m²
11.42m²
10.24m²
4.64m²
4.98m²
32.28m²
8.21m²
4.17
19.09m²
39.73m²
3.09m²
11.41m²
54.71m²
33.51m²
19.39m²
2.45
25.52m²
19.88m²
13.42m²
8.98m²
8.79m²
14.26m²
3.80m²
SPECIAL ARRIVALS (NO CUSTOMS)
PECIAL DEPARTURES (UNSCREENED):
1 X one-person, two-way
GENERAL PUBLIC DOORS:
FOR SPECIAL FLIGHTS
1 X two-person, two-way


173 13m²
A
ENPLANING GATE:
2 X one-person, one-way
ALL REGULAR
DOMESTIC ARRIVALS:
1 X two-person, one-way.
ALL REGULAR TRANSBORDER/
INTERNATIONAL ARRIVALS:
2X one-person, one-way.
952 80m²
11 02m²
15 72m²
4 79 4 28m²
29 27m²
20 62m²
12 55m²
10 68m²
10 68m²
10 68m²
10 68m²
10 68m²
811 36m²
64 35m²
15 24m²
16 41m²
14 91m²
10 98m²
794
11 30m²
19 02m²
GENERAL PUBLIC DOORS:
1 X one-person, two-way (swing)
1 X two-person, two-way (slide)
STE-FOY
AIRPORT
ARRIVAL SECTION
1558-0502-4
A


LEGEND
ALL PEOPLE
DEPARTURES
ARRIVALS
COUNTING THRESHOLD
ENPLANING GATE:
2 X one-person, one-way
ALL SCREENED DEPARTURES
(SECURITY CHECK AREA):
2 X one-person, two-way
GENERAL PUBLIC DOORS:
1 X one-person, two-way (swing)
1 X two-person, two-way (slide)
A
A
18.78m²
35.77m²
30.20m²
14.90m²
46.41m²
7.97m²
17.77m²
7.71m²
11.58m²
3.43
47.10m²
34.81m²
12.86m²
8.88m²
3.64m²
4.45m²
4.40m²
3.81m²
9.39m²
43.47m²
43.36m²
38.54m²
14.22m²


ENPLANING/DEPLANING GATE:
1 X two-person, two-way
STE-FOY
AIRPORT
DEPARTURE SECTION
1559-0502-5
98.20m²
116.86m²
143.64m²
15.72m²
16.41m²
18.60m²
10.04m²
15.32m²
7.71m²
15.53m²
47.10m²
31.85m²
11.98m²
34.81m²
33.50m²
58.59m²
9.18m²
5.05m²
33.57m²
16.43m²
36.81m²
12.53m²
13.10m²
9.66m²
15.59m²
20.01m²
16.76m²
13.54m²
14.58m²
5.18m²
20.92m²
12.86m²
5.48m²
11.32m²
13.24m²
14.95m²
DOMESTIC ENPLANING (UNSCREENED)
DEPLANING GATE (AERO-TAXI):
1 X one-person, two-way
GENERAL PUBLIC DOORS:
1 X one-person, two-way (swing)
1 X two-person, two-way (slide)
14.63m²
11.93m²
15.67m²
20.44m²
19.77m²
6.68m²
13.09m²
GENERAL PUBLIC DOORS:
1 X one-person, two-way (swing)
1 X two-person, two-way (slide)

APPENDIX C

TEST/PILOT PROJECT FOR DORVAL AIRPORT

- COMPUTER SYSTEM ARCHITECTURE
- PRELIMINARY LIST OF EQUIPMENT
- PAMPHLETS/DOCUMENTATION ON EQUIPMENT

LIST OF EQUIPMENT FOR TEST OR PILOT PROJECT

DESCRIPTION	MFG	#
Sensing devices: infra-red Modulated light, pair of transmitter and receiver - active range up to 15 feet - 10 msec response - 24 VDC - output NPN-200 ma (normally OPEN)	Electromatic	MHR-05-NNO or equivalent
With reed relay for contact closure - contact rating 10VA at .5 Amps - operate time less than 1 ms - 24 VDC Mw	Magnecraft	W107DIP-3
Signal conditioning subsystem Monitoring controller (up to 61 points per module) - micro processor based - multiple input units (8) - interfaces - RS-232 to computer - RJ-11 to MI-6	Slage	SE-902S
Contact monitoring - monitors up to 7 contacts per module - multiplex data on twisted pair to controller	Slage	MI-6
Uninterruptible power suply for slage 902S controller	Slage	UPS-3
Limited distance data set - RS-232 connection to DTE equipment - up to 4 miles at 50 to 9600 BPS - powered by EIA data and control signals - use 4 wire unloaded mettallic circuits on 26 AWG cables	Gandalf	Mlds 122
Link subsystem - RS-232 cables - RJ-11 connectors and cabling (MI-6 to 902) - power cables for UPS and micro/mini computer		

LIST OF EQUIPMENT FOR TEST OR PILOT PROJECT

DESCRIPTION	MFG	#
Central station subsystem Computer: see architecture for micro or mini computer		
Laser printer - 8 pages per minutes - 300 by 300 dots per inch - 250 sheets input and output cassette - 16 resident fonts - accepts precoded ROM font carbridges (2)	Digital equipment	LN-03 or equivalent
Uninterruptible power supply for MicroVAX II - 120 VAC/60 hz - 30 minutes (half load) - 1440 VA - 1050 watts - BA 123 based with one cabinet	Digital equipment	H7229-AD
Uninterruptible power supply for micro-computer - 120 VAC/60 hz - 3.5 hours (full load) - 8 hours (full load) - 4.3 Amp - 500 VA	Pylon	UPS-500 Battery 800
Software Operating system Micro MS-DOS 3.3 or later version Mini MICRO VMS license for 1 to 2 user	Microsoft Digital Equipment	MS-DOS VMS
Monitoring and management system Micro: Collection, storage and recall management system for 80286 or 80386 under DOS	Slage	5795A
OR		
Mini: System 1 plus monitoring management system for MicroVAX II under VMS	Software House	C-CURES

DORVAL AIRPORT

Central station subsystem: Pilot project

Minicomputer architecture

Microvax II including:

- CPU: Microvax II
- 5 Mbytes RAM memory
- disc controller RQDX-3
- tape backup TK-50 95 Mbytes
- 8 ports serial interface DHV-11-M with DMA and modem control
- BA 123 cabinet
- 120VAC/60 hz power supply
- Winchester disc 71 Mbytes RD-53

DORVAL AIRPORT

Central station subsystem: Test project

Micro-computer architecture

- Processor INTEL 80286 horloge 20 Mhz zero one wait state
- 640 Kb RAM memory
- 1 diskette drive 5¼ 1.2 Mb
- enhanced 101 keyboard
- 1 parallel part (centronic)
- 2 serial ports
- minimum of three expansion slots (2 AT type, 1 half size)
- capability for adding a math coprocessor (Intel 80287)
- 40 Meg hard disc 28 ms access time
- tape backup 60 mb (cartridge)
- clock and battery protection
- EGA/CGA graphic card
- monochrome monitor 14"

SE 902

Two-Door Proximity Access Control and Alarm Monitoring System

The SE 902 is a complete proximity access control / alarm monitoring system for one or two entrances (doors, gates, turnstiles) and up to 61 alarm points. This is the ideal access control system for smaller buildings and industrial / office park developments.

The SE 902 controls access for up to 2,600 individually numbered command keys or up to 1,000 command keys with names associated to each cardholder.

The system can support these additional devices: up to eight multiple point monitor units with six input points each, up to four relay outputs with 4 relays each, up to two VIP keypads and up to two DLS card reading sensors per unit.

The versatile and expandable SE 902 provides intelligent access control and alarm monitoring in a state-of-the art intelligent network.

SCHLAGE ELECTRONICS.
Part of worldwide Ingersoll-Rand

Benefits:

Flexible design allows networked system installation.

Reduces overall cost of complete security management.

Detailed or condensed reports for tracking cardholders.

Increases value and marketability of any building or property.

Allows for world-wide "Global Access."™

Applications:

Where reliable and proven proximity technology is needed to control access, track cardholders, monitor alarm points and provide reports of such activities.

New and remodeled small office buildings or office parks where an integrated access control and alarm monitoring system is required.

Where large organizations require a centralized security management system that allows individuals access to multiple sites with a single "Global Access™" command key.

Anywhere control and reporting functions for an access control system can be used in conjunction with an alarm monitoring station.

Where an expandable networked system can be used with up to 2,600 employee command key (card) codes stored in memory.

In facilities where a standalone or networked security management system is required to reduce overall security costs. Use may range over the entire facilities, or within specified areas or floors only.

Anywhere linking remote buildings, parking structures, special storage areas and/or similar small facilities to a centralized monitoring location is required.

Basic Features:

Modular, distributed design allows for easy installation of system components along a single data line.

Tested ready-to-run systems.

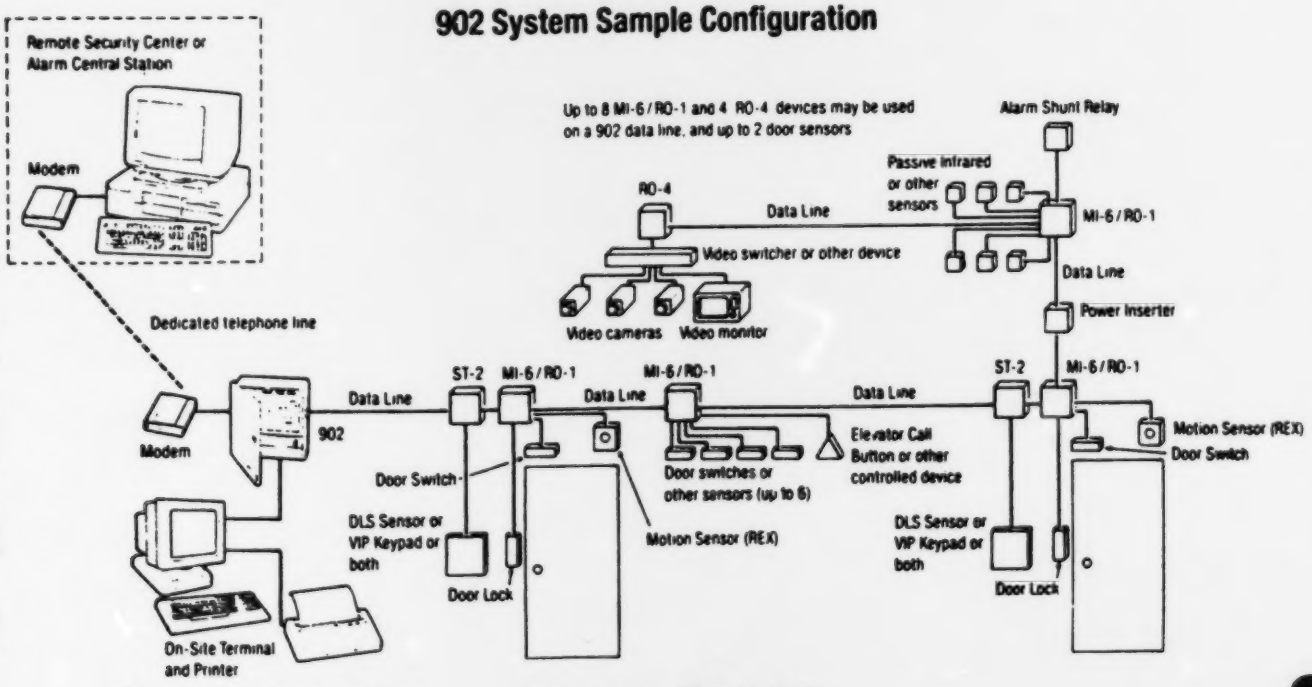
Simple start-up and easy operation.

Fully integrated access control and alarm monitoring systems.

Proven customer service.

Guaranteed reliability.

902 System Sample Configuration



Note: Lock power may be supplied by UPS-3, power inserter, or via a local transformer.

Note: Power inserters used as required by the total number of devices and the total distance of the network. Maximum distance of the sum of all the networked segments is 4000'.

902 System Features:

ACCESS CONTROL:

- Access Control locations 2
- Cardholders (1050 keys only) ..... up to 2,600, or 1000 with 12 character name
- Access Codes 15
- Multiple Input units (MI-6 / RO-1) 8
- Relay Output units (RO-4) 4
- Keypads (VIP) 2
- Time Intervals (total) 128
- Holidays (user-defined) 30
- Clock (time / date / year)
- Group key programming (from sensor)
- Route trace of specific keys
- Program, clock, building mode and data maintained on power loss
- User-defined auto-unlock schedule
- Hard / Soft anti-passback with "forgiveness"
- Adjustable unlock / shunt times
- Manual lock / unlock from terminal
- Manual relay activate / deactivate from terminal
- Normal and reverse lock operation
- Operator-defined door relays
- Operator-defined building mode switch and indicators
- Open / forced door detection
- Interface for printer / terminal
- Interface to RS-232C
- Shipped pre-programmed for easy start-up
- Uses keyboard commands similar to those for the SE 804S / 808S; 4 and 8 door controllers
- Optional event storage and recall (SE 5795)
- Programmable dial-out port for: alarms, initiates phone call transactions dial-up communications, programming send messages

ALARM MONITORING:

- Monitored / supervised contacts (MI-6 / RO-1) .. 7 (6 standard, 1 tamper)*
- Monitored / supervised contacts (RO-4) ..... 1 (1 tamper)*
- Monitored / supervised contacts (902S CPU) ..... 2 (1 tamper, 1 power fail detection)*

*NOTE: Tamper inputs and power fail detect inputs may be used for other monitoring purposes if additional inputs are required and tamper / power fail is not.

- Output contacts (902S CPU) ..... 2 (2 Form 1C)
- Output contacts (RO-4) ..... 5 (4 Form 1C, 1 12V switch)**
- Output contacts (MI-6 / RO-1) ..... 2 (1 Form 1C, 1 12V switch)**

**NOTE: Standard Form 1C relays supplied. Additional switch contact is available for user supplied relay driven by 12 V DC @ 35 MA.

- Operator-selected latched output 1
- Contact names (12 characters)
- Contacts assignable to any function
- Contact designation as alarm / non-alarm event

REPORTING & CONTROL FEATURES:

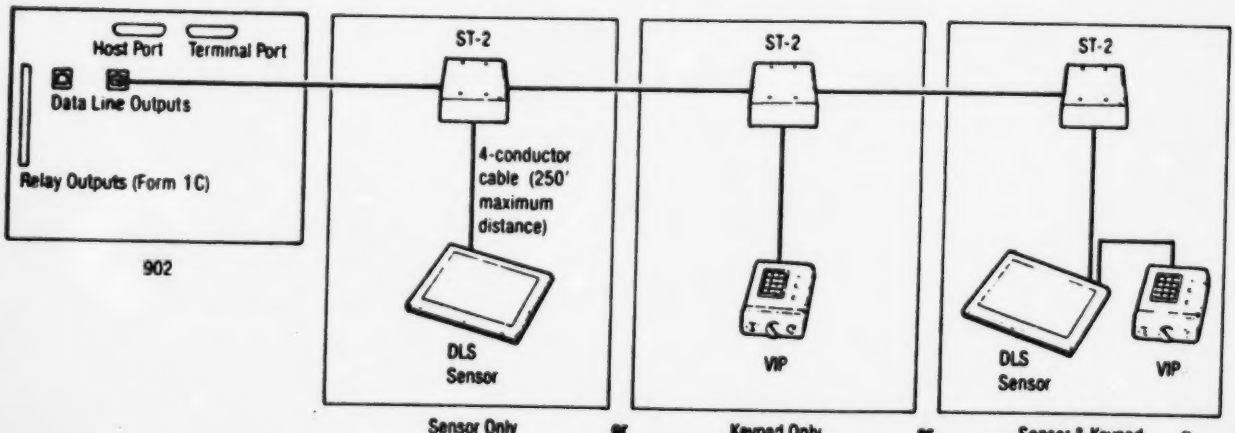
Proprietary:

- Silent terminal keyboard / printer "Help" menu
- Plain English message formats
- Recognizes partial spelling of command and days
- Transactions stored if terminal unavailable 200
- User-defined report formats 32
- Operators identified 8
- Authorization levels (password required) 6
- Status reports
- Data base printouts
- Identification of key which opened / closed

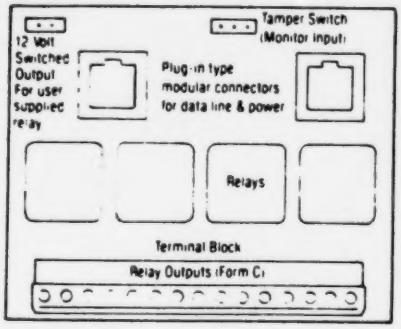
Remote:

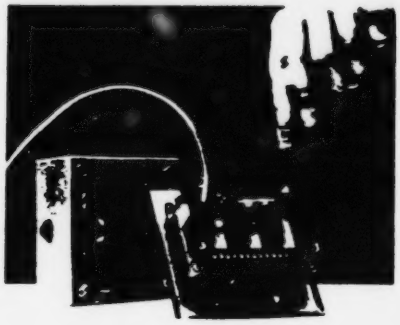
- Same function as local terminal
- Silent keyboard / printer or user host computer (ASCII terminal)
- Programmable from remote location
- Automatic dial-up operation
- Works with both local and remote terminals
- Report preceded by I.D. information
- Warning of past due building closure
- Multiple local site from one central site

Sensor and Keypad Configurations
(Maximum of two per system)

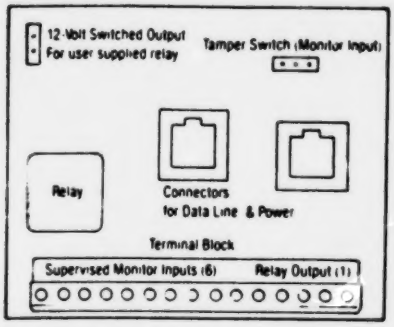


RO-4


12 Volt Switched Output For user supplied relay
Tamper Switch (Monitor Input)
Plug-in type modular connectors for data line & power
Relays
Terminal Block
Relay Outputs (Form C)



MI-6 / RO-1


12 Volt Switched Output For user supplied relay
Tamper Switch (Monitor Input)
Relay
Connectors for Data Line & Power
Terminal Block
Supervised Monitor Inputs (6)
Relay Output (1)

Specifications:

Dimensions are in inches and cm unless otherwise noted.

SE 902S CPU:
Microprocessor circuit board mounts in metal housing. Dimensions 14.25 (36.2) H x 12.50 (31.7) W x 4.19 (10.6) D.

ST-2 Security Tap:
One for each sensor or VIP. Dimensions: 4.50 (11.4) H x 4.56 (11.6) W x 2.19 (5.6) D.

UPS-3 Uninterruptible Power Supply:
Powers 902S and provides limited (1 amp) DC lock power. 24 VDC. U.L. Listed. CSA Approved. Dimensions: 3.50 (8.9) H x 6.62 (16.8) W x 11.50 (29.2) D including mounting flange.

DLS Card Reading Sensors:
Lexan-encased. Mount on surface, behind glass or conceal in wall. Dimensions: 7.50 (19) H x 7.50 (19) W x 1.12 (2.8) D.

SE 1050 Command Keys:
Dimensions: 3.36 (8.5) H x 2.12 (5.4) W x 0.1 (0.25) D (thick).

MI-6 / RO-1 Multiple Input / Relay Output:
6 input contacts / 1 Form 1C relay output contact. Located anywhere on the distributed system. Dimensions: 4.50 (11.4) H x 4.56 (11.6) W x 2.19 (5.6) D.

RO-4 Relay Outputs:
4 Form 1C relay output contacts. Located anywhere on the distributed system. Dimensions: 4.50 (11.4) H x 4.56 (11.6) W x 2.19 (5.16) D.

VIP Keypad (Verified Identification of Personnel Keypad)
Can be used alone or with DLS sensor, 12 key keypad, 3 LED indicators. Dimensions: 4.50 (11.4) H x 4.56 (11.6) W x 2.19 (5.6) D.

ENVIRONMENTAL SPECIFICATIONS:

CPU, ST-2, UPS-3, MI-6 / RO-1, RO-4, VIP: 20 F TO 120 F (– 7 C to 49 C)

Command Keys: – 50 F to 120 F (– 45 C to 49 C), Storage (max.): 170 F (76.6 C)

Sensors: – 40 F to 140 F (– 40 C to 60 C)

Relative Humidity: 10% to 95% non-condensing except sensors. Sensors rated for outdoor use to withstand condensation, rain, snow and ice.

For additional information consult the Schlage Electronics Arch. / Eng. Binder available from:

SCHLAGE ELECTRONICS

Founded in 1973, Schlage Electronics is known for its technological innovations, many of which have been adopted by the security industry and become de-facto standards.

Schlage Electronics is part of worldwide Ingersoll-Rand, a multi-billion-dollar corporation with a 100-year reputation for quality and integrity.

SCHLAGE ELECTRONICS
Part of Worldwide Ingersoll-Rand
5452 Betsy Ross Drive
Santa Clara, CA 95054-1102, USA
(408) 727-5170
(800) 227-1667
FAX: (408) 727-6707
Telex: 171122 SCHLAGE SNTA

INGERSOLL-RAND NETHERLANDS P/A SCHLAGE ELECTRONICS EUROPE
Kattensingel 17
2801 CA Gouda
Netherlands
Telephone 01820-25233
FAX: (1) 820-23832
Telex: 28692 SEE NL

INGERSOLL-RAND FAR EAST
19th Floor, Malaysia Building
50 Gloucester Road
Hong Kong
Telephone: (5) 270183
FAX: 011-8525295976
Telex: 86278

INGERSOLL-RAND JAPAN, LTD.
Kowa Building, No. 17
2-7 Nishi-Azabu, 1-Chome
Minato-P, Tokyo 106
Japan
Telephone: (03) 403-0641-7
FAX: 81-3-4015282
Telex: 22929

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SE 5795B

Security Management System

The SE 5795B is a powerful, yet simple to use, event collection, storage and recall program for SE "S" class proximity access control and alarm monitoring systems. It runs on a powerful, high speed, IBM compatible, SE computer specifically designed for around the clock security applications.

Storing 180,000 events (many months' worth in a typical application), the SE 5795B provides for the selective recall of those events using a powerful word association process.

The SE "S" class of proximity access control and alarm monitoring systems includes the 808S unit, 804S unit, 708S unit and the 764S unit.

Benefits:

Fast and easy to learn.

Guaranteed reliability.

Proven customer support.

Great design flexibility for new and existing installations.

Applications:

Where centralized data storage and retrieval of access control and alarm transactions is required.

Where upgrading existing and / or new standalone access control and alarm monitoring systems is required.

Where monitoring and controlling multiple standalone access control and alarm monitoring units from one location is required.

Basic Features:

Powerful word association logic for event recall.

Proven technology.

E.G.A. color graphic displays.

Simple menu-driven operations.

Customized reports.

Low-cost event storage and retrieval.

Compatible with existing SE "S" class access control systems.

5795B System Features:

- Event messages stored 180,000
- Characters for employee names 26
- Additional 16 character employee description field 2
- Unique word association logic for event recall:

  All events in a defined day / time window.

  Only defined words, numbers or groups of words and numbers.

  System will immediately jump to the specified date when searching data records at approximately 3 transactions per second.
- High performance, 10 MHz, PC / AT compatible computer.
- Designed for 24 hour operation.
- Upgradeable to SE 5800 Access Control Management System.
- 15 month warranty from date of shipment.
- Operator instructions attached to any alarm or event 99
- Preset words or numbers used for frequent recall reports 10
- Reports can be printed, stored, viewed or downloaded to floppy disk.
- Employee lists can be sorted by name, card number or description fields.
- System will search for and look at specific events.
- Alert symbol (*) automatically blinks when alarms and / or events have occurred.
- User translations via edit functions.
- Reports generated from stored data on hard or floppy disk.
- Uses access control data base.
- Password protection.

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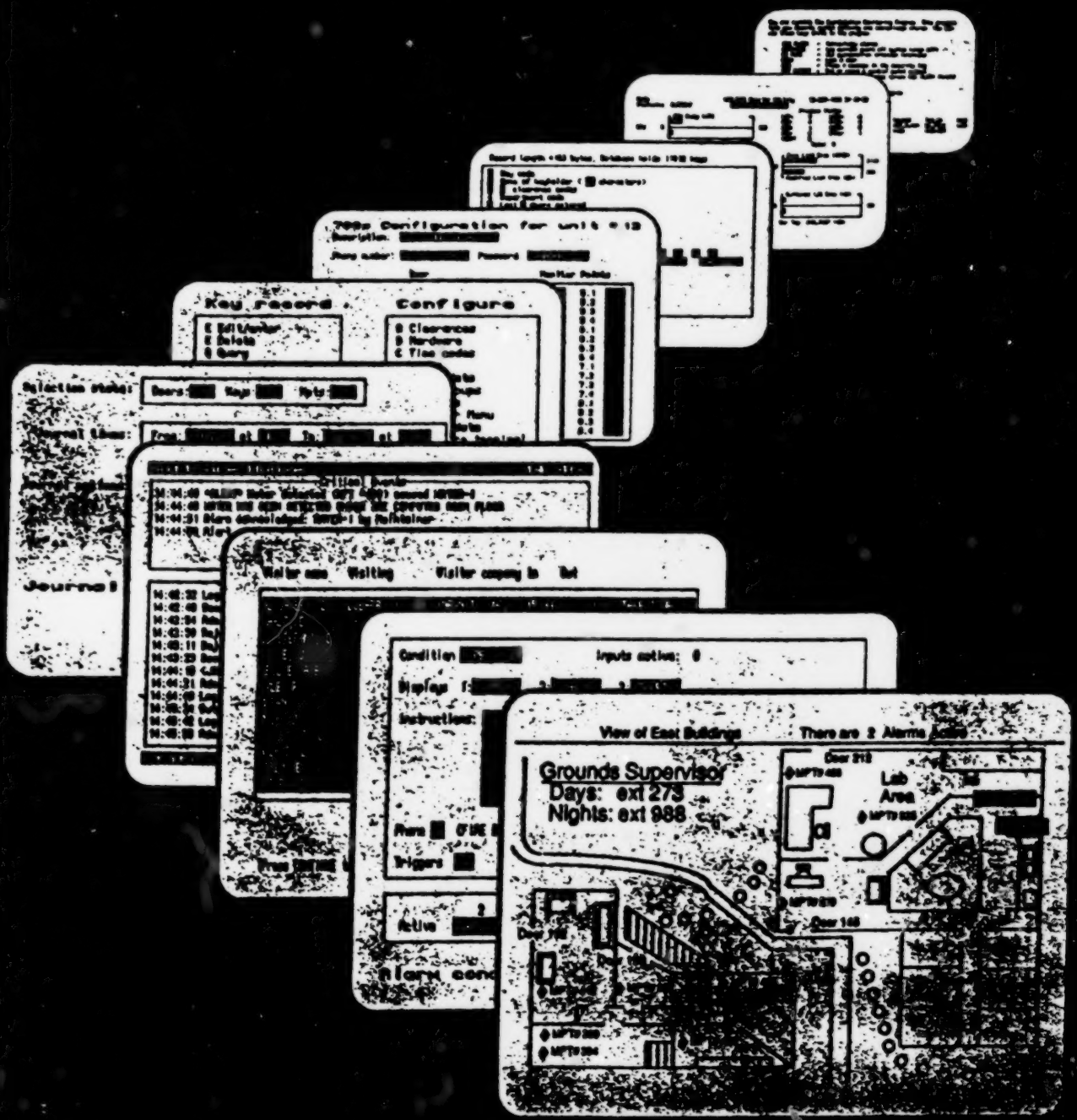
C·CURESystem 1 Plus™

Security Management System



Capacities

Access Control

Simultaneous users	2 - 20
Operator passwords	80
Operator privilege levels	20
Operator classes	256
Events stored on-line	1.2 to 2.8 million
Card readers	256†
Card readers on remote devices	512
Cards in database	32,000†
Door groups	100†
Time intervals	128†
Time codes	128†
User-defined holidays	20
Number of security levels	127†
Security levels per person	6
Anti-passback regions	36
Anti-passback privileges	4
User-defined character fields per cardholder	8
User-defined number fields per cardholder	4

Elevator Control

Elevators	25
Floors per elevator	80
Floor groups	25
Elevator clearances	128

Watchtour

Tours	100
Guards	100
Simultaneous tours	25
Stop types	card readers, monitor points, or telephones

Alarm Monitoring

Monitor points	1,024 minimum†
Alarm conditions	1,000†
Alarm groups	100†
User-drawn maps	300†
Control points	1,024 minimum†
Control point groups	200†

VAX Computer

Hard disk capacity	30 - 280+ megabytes*
RAM memory	1.5 - 16 megabytes*
Maximum number of I/O ports	13 - 33*
Back-up media	1.2 megabyte floppy discs, or 90-megabyte cartridge tape
Operating environment	50° to 90° Fahrenheit 20% to 80% relative humidity

Technologies Supported

Cards and Field Devices:

Wiegand
Schlage Proximity
Identification Devices
Rusco
NCS 1151
Sensor Engineering SAS-3
Mag Stripe (high/low coersivity)
Hirsch Keypads
Hirsch Models 2 and 8

Alarm Devices:

Vindicator 2100 (meets DIAM50-3)
Radionics 6000 and 6500

Biometric Devices:

EyeDentify retinal scanners
Campbell Engineering portals

*Figures are for MicroVAX computers. Larger VAXes have greater capacity.

†Greater capacity available on expanded system. Check with Software House for details.

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VAX, MicroVAX, DECTalk, DECNet, and Ethernet are trademarks of Digital Equipment Corporation.

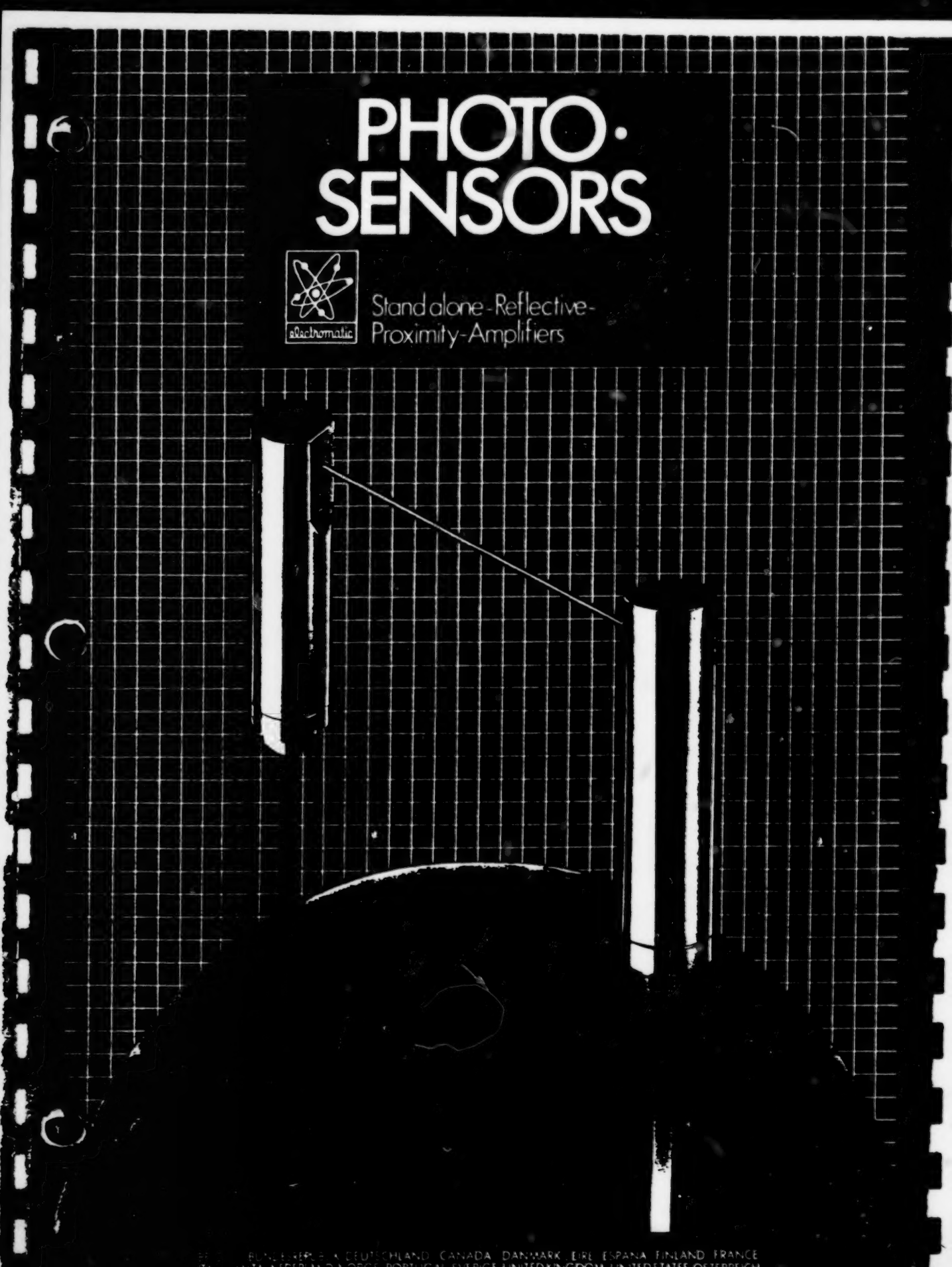
Software House

1030 Massachusetts Avenue
Cambridge, Massachusetts 02138
Telex: 333869 CCURE
Telephone (617) 661-7023
Fax: (617) 661-9550

PHOTO· SENSORS

electromatic

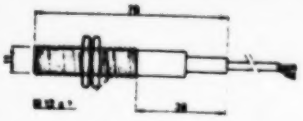
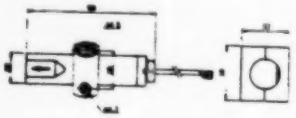
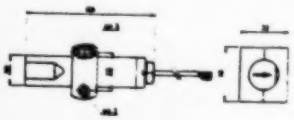
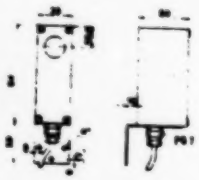
Stand alone - Reflective - Proximity - Amplifiers



BENELUX DEUTSCHLAND CANADA DANMARK EIRE ESPANA FINLAND FRANCE
ITALIA NEDERLAND NORGE PORTUGAL SVERIGE UNITED KINGDOM UNITED STATES OF AMERICA

With output functions Ambient temperature -20 to +60 °C

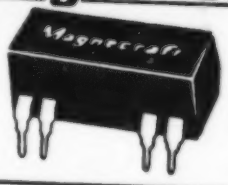
Infrared modulated light — Separate transmitter and receiver

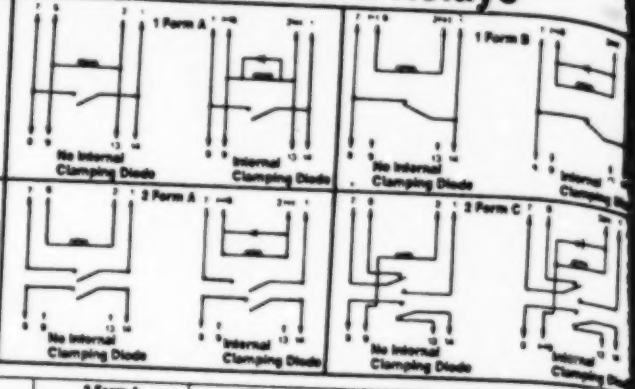
Dimensions	Act. range (m)	LED-indication	Adjustable	Imp. per sec.	Power supply	Output	Norm op./clos.	Load	Wiring diagram	Connections	Type numbers
	5	–	–	100	10-30 VDC	NPN	NO	200 mA	A	2 m cable	MHR 05 NNO
	5	–	–	100	10-30 VDC	NPN	NC	200 mA	B	2 m cable	MHR 05 NNC
	5	–	–	100	10-30 VDC	PNP	NO	200 mA	C	2 m cable	MHR 05 PNO
	5	–	–		10-30 VDC				E	2 m cable	MHT 05
	5	–	–	100	10-30 VDC	NPN	NO	200 mA	A	2 m cable	MMR 05 NNO
	5	–	–	100	10-30 VDC	NPN	NC	200 mA	B	2 m cable	MMR 05 NNC
	5	–	–	100	10-30 VDC	PNP	NO	200 mA	C	2 m cable	MMR 05 PNO
	5	–	–	100	10-30 VDC	PNP	NC	200 mA	D	2 m cable	MMR 05 PNC
	5	–	–		10-30 VDC				E	2 m cable	MMT 05
	5	–	–	100	10-30 VDC	NPN	NO	200 mA	A	2 m cable	MNR 05 NNO
	5	–	–	100	10-30 VDC	NPN	NC	200 mA	B	2 m cable	MNR 05 NNC
	5	–	–	100	10-30 VDC	PNP	NO	200 mA	C	2 m cable	MNR 05 PNO
	5	–	–	100	10-30 VDC	PNP	NC	200 mA	D	2 m cable	MNR 05 PNC
	5	–	–		10-30 VDC				E	2 m cable	MNT 05
	10	+	–	20	24 VAC	relay	NO	5 A ohmic	F	2 m cable	METRM 10 024
	10	+	–	20	120 VAC	relay	NO	5 A ohmic	F	2 m cable	METRM 10 120
	10	+	–	20	220 VAC	relay	NO	5 A ohmic	F	2 m cable	METRM 10 220

MXR: receiver
MXT: transmitter
are possible combinations.

Magnecraft®

DIP Reed Relays





CONTACT FORM	1 Form A	2 Form A	1 Form B	1 Form C	2 Form C
Contact Rating (maximum)	10VA @ 0.5 Amps	10VA @ 0.5 Amps	10VA @ 0.5 Amps	8VA @ 0.25 Amps	8VA @ 0.25 Amps
Operate Time Typical	330 Microseconds	620 Microsec	400 Microsec	500 Microsec	750 Microsec
Bounce Time Typical	180 Microsec	400 Microsec	150 Microsec	200 Microsec	450 Microsec
Contact Circuit Resistance	200 Milliohms				
Insulation Resistance	10^{10} ohms at 100 VDC Minimum				
Life Typical (end of life 1 ohm)	5×10^8 (25×10^8 for low level type)			5×10^8	
Dielectric Between Contacts	200VDC Minimum				
Dielectric Between Coil and Contacts	1000VDC Minimum				
Shock	100 G's, 11 milliseconds @ ½ sinewave				
Vibration	20 G's, 0-5000 Hz operating				
Ambient Temperature	-45°C to +85°C				

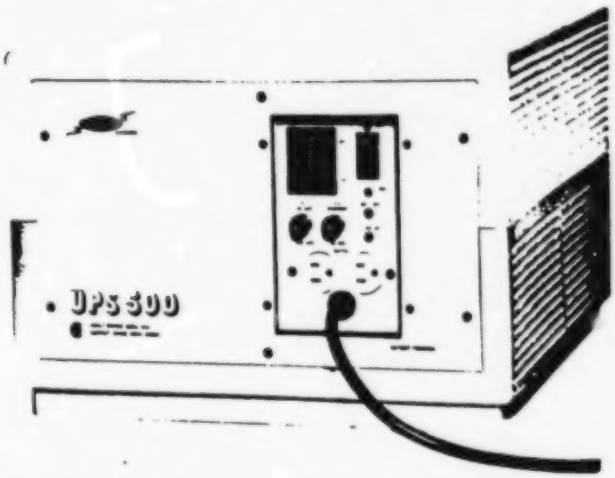
CLASS 167 DIP, SPST-NO, 1 FORM A, 1.5 A

CLASS 173 DIP, SPDT, 1 FORM C

PYLON

UNINTERRUPTIBLE POWER SUPPLY

Bulletin G-23



MODEL UPS-500

The PYLON® Model UPS-500 is engineered to provide back-up for applications where a reliable source of AC mains power is critical. Used in such areas as telecommunications (e.g. telephone/transmitter for police, fire, ambulance, security and taxi services), computing or electronic cash registers, where a commercial power outage or brown-out cannot be tolerated, the PYLON® UPS-500 will provide reliable back-up service.

The unit is true UPS; so switch-over times are not encountered. An excellent surge and transient protection will guard your equipment against line induced malfunction or potential break-down. The PYLON® UPS-500 is simple to use - merely plug in line cord, plug in your equipment and turn on.

The PYLON® UPS-500 provides a sine wave output of nominal 117V AC, 60Hz conservatively rated at 500VA. The frequency is crystal controlled and synchronized to the line. The output is regulated, isolated, short circuit protected and can provide an extra surge capacity exceeding 600VA. Batteries are protected from deep discharge damage by a low voltage disconnect sensor and are automatically recharged when commercial power resumes. The unit is convection cooled and incorporates a thermal cut-off switch as added protection. In the standard unit, inverter and charger are housed in the same chassis.

A variety of battery options are available. For option 120, a small battery case is supplied. A larger lower compartment chassis is available to house the batteries for options 280, 550 and 800.

While the PYLON® UPS-500 is a commercial unit, it is attractively packaged and provides quiet operation for an office environment.

®REGISTERED TRADE MARK USA and CANADA

APPLICATIONS

Telephone Systems
Electronic point-of-sales terminals
Small computer based equipment
Remote terminals
Word processing equipment
Communications equipment
Security alarms
Medical equipment

FEATURES

Black-out protection
Brown-out protection
Surge protection
Regulated output
Short circuit protection
Line synchronization
Crystal controlled frequency
Expandable battery options
Auto LV battery disconnect
Thermal cut-out
Safety interlock
CSA approved

(PATENTS PENDING)
(ALL RIGHTS RESERVED)

SPECIFICATIONS

Input

Voltage:	117V AC nominal
Voltage Range:	−20%, +10% (95 to 130 volts)
Current:	10A nominal
Frequency:	60 Hz ±10%

Output

Voltage:	117V AC nominal
Current	4.3 A max.
Power (continuous):	500 VA max.
Load Regulation:	± 5%
Line Regulation:	± 5%
Distortion:	less than 5%
Overload Surge Capacity:	140% of max. rated load for 5 min.
Reactive Load Performance:	Power factor 0.8 leading and lagging
Frequency:	60 Hz. line synchronized
Frequency Stability:	± 0.01% crystal controlled
Efficiency:	70% at full load unity power factor.

Protection

- Automatic low voltage battery disconnect to prevent excessive drain.
- Separate output line fuse
- Input thermal breaker protection for inverter
- Inverter output short circuit protection
- Battery reversal fuse protection
- Battery short circuit protection
- Thermal cut-out
- Automatic transfer to mains in the event of UPS failure; transfer time 20mS
- Line surge immunity to ANSI 472

Operating Temperature and Humidity

0°C to 40°C , 0% to 95% (non-condensing)

Power Cord

9', 2 pole, 3 wire, 15A power cord

Receptacles

Two 15 amp duplex receptacles

Battery Options

Option	A hr	Battery Case	Approx back up at full load
120	12	LBC 120	20 minutes
280	28	LBC 100	45 minutes
550	55	LBC 100	2 hours
800	80	LBC 800	3.5 hours
2 800	160	LBC 800×2	8 hours

Battery recharge time

10 minutes charging per 1 minute usage during power outage

Mechanical

	Option	Height (mm)	Width (mm)	Depth (mm)	weight
UPS 500	– –	12" (305)	17" (432)	19.75" (502)	105 lbs (48Kg)
LBC 100	280	13" (330)	17" (432)	19.75" (502)	93 lbs (42Kg)*
LBC 100	550	13" (330)	17" (432)	19.75" (502)	173 lbs (79Kg)*
LBC 120	120	8.5" (216)	13" (330)	5.5" (140)	48 lbs (22Kg)*
LBC 800	800	15.375" (391)	17" (432)	22.25" (565)	220 lbs (100Kg)*

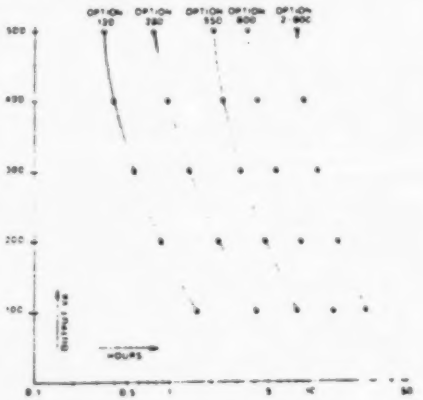
*includes weight of case and set of batteries

Finish

Two tone grey

220 VAC, 50Hz available upon special request

Back Up Times



ORDERING INFORMATION

Model UPS-500, Option 120	UPS unit with 12A hr batteries and battery case LBC-120
Model UPS-500, Option 280	UPS unit with 28A hr batteries, and battery case LBC-100
Model UPS-500, Option 550	UPS unit with 55A hr batteries, and battery case LBC-100
Model UPS-500, Option 800	UPS unit with 80A hr batteries and battery case LBC-800
Model UPS-500, Option 2-800	UPS unit with (2) two sets of 80A hr batteries and (2) two LBC-800's

Pylon carries a series of other UPS and inverter models. We welcome your enquiries.

PYLON PRODUCTS YOU CAN COUNT ON

PYLON

PYLON ELECTRONIC DEVELOPMENT company, ltd.

2300 Victoria St.,
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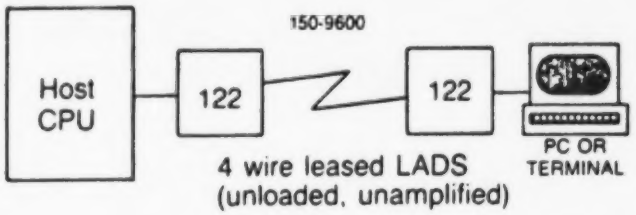
Telex 05-821680

Form 12L83 /E

gandalf

mLDS 122

asynchronous limited distance data set



The Gandalf mLDS 122 limited distance data set is compatible with Gandalf's LDS 120, LDS 121 and RM 3120 for asynchronous operation. Powered entirely from the EIA RS232C interface via data and control signals, mLDS 122 plugs directly into data terminal equipment (DTE). Male or female connectors must be customer specified. Neither EIA cable or a power cord is required.

The compact mLDS 122 operates from 50 to 9600 bps at distances up to 4.0 miles. The distance does not vary as a function of the data rate. The mLDS 122 is intended for 4-wire unloaded, point-to-point, operation. Break signals (long space) can be handled. The mLDS 122 meets A.T.&T. pub. 43401. DC continuity is not required. Units are provided in a plastic enclosure with an instruction label for ease of installation.

features

- Cost-effective data set
- Range to 4.0 miles at 50 to 9600 bps
- Powered by EIA data and control signals
- Plugs directly into DTE devices
- Line compatible with LDS120, LDS121, RM3120
- Handles break signals (long space)
- Easy installation – no adjustments required
- Choice of male or female interface connectors
- Requires no desk space
- Auto-Equalized

Victoria (604) 383-2024 | Vancouver (604) 736-2611 | Edmonton (403) 482-5651 | Calgary (403) 283-6333 | Winnipeg (204) 284-3840 | Toronto (416) 491-6070 | Ottawa (613) 596-3841 | Montréal (514) 463-0123 | Québec (418) 683-1643

Dartmouth (902) 463-0202 | Burlington (416) 681-0506 | London (519) 681-5444

specifications

Line Requirement:

The unit operates over dedicated 4-wire unloaded metallic circuits and meets requirements of A.T.&T. Pub. 43401. DC continuity is not required: both the transmitter and receiver are transformer coupled. Longitudinal balance exceeds 60 dB. No adjustment is required as the mLDS is equipped with a two stage compromise auto-dash equalizer.

Range:

To 4.0 miles (7 km) over 26 AWG (0.4mm) cable pairs.

Speed:

The data sets are suitable for asynchronous operation from 50 to 9600 bps and can accommodate break or long space signals.

Operating Mode:

Full duplex: RTS/CTS delay = 0 ms

Interface:

The mLDS 122 is equipped with an industry standard EIA RS232C interface connector.

Connections are shown in the following table.

PIN NO		
2	TxD	Transmit Data
3	RxD	Receive Data
4	RTS	Request to Send
5	CTS	Clear to Send
6	DSR	Data Set Ready
7	GND	Signal Ground
8	DCD	Data Carrier Detect
20	DTR	Data Terminal Ready

Models:

Models are available with either Male (mLDS 122M) for most terminals, or Female (mLDS 122F) interface connectors.

Power:

Not required – the mLDS 122 derives power entirely from the data and control signals of the DTE device.

Dimensions:

3.85 x 1.70 x 0.93 inches (9.78 x 4.32 x 2.36 cm)

Weight:

4 oz. (100g) approximately

Environment:

Operating temperature – 0° to 50°C

Relative humidity – 0 to 90% non-condensing

Specifications subject to change without notice.

gandalf®

07 86
PRINTED IN CANADA

Subsidiaries of Gandalf Technologies Inc.

Gandalf Data Limited,
100 Colonnade Road
Nepean, Ontario, Canada
K2E 7M4
Tel: (613) 226-6500
Tlx: 053-4728

Gandalf Data, Inc.
1020 S. Noel Avenue,
Wheeling, Illinois 60090
Tel: (312) 541-6060
TWX: 910-651-4951

Gandalf Digital
Communications Ltd.,
19 Kingsland Grange,
Woolston
Warrington, Cheshire
WA1 4RW England
Tel: (0925) 818484
Tlx: 629494

Gandalf Nederland B.V.
Kabelweg 37
1014 BA Amsterdam,
Holland
Tel: (020) 867611
Tlx: 15694

Gandalf Pacific Pty Ltd.
Chatswood Village
Unit 4, 47 Neridah St.
Chatswood, N.S.W.
2067 Australia
Tel: 61-2-419-5977

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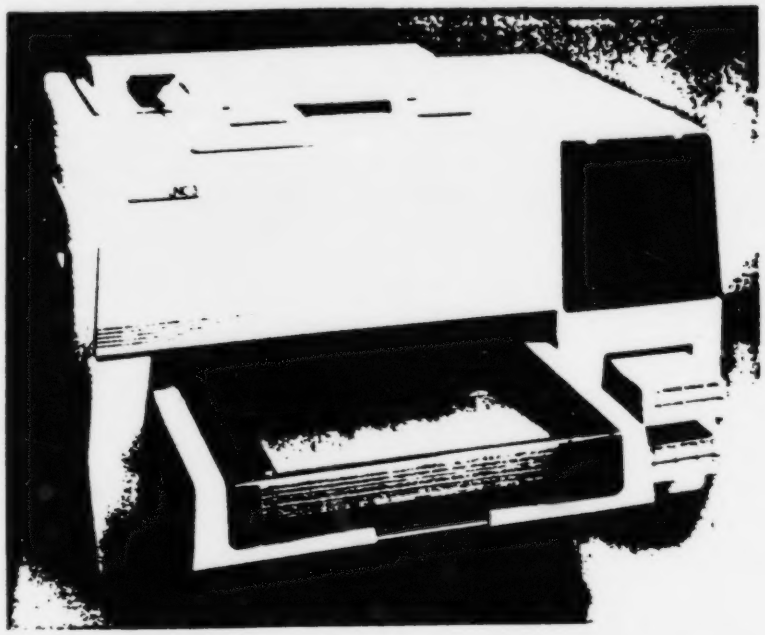
The LN03 laser printer is a desktop unit that employs electrophotographic imaging and xerographic printing to produce eight pages of text per minute. The LN03 comes with three character sets in 16 fonts for both portrait and landscape orientation. Print resolution is 300 by 300 dots per inch. Precoded ROM font cartridges or programmable RAM cartridges can be inserted into one of two option slots on the front panel. The LN03 has a 250-sheet output tray and an adjustable 250-sheet input tray for standard and European size paper, label sets, or transparencies. A standard RS-232 serial interface is provided for connection to stand-alone or networked Digital systems.



Features

- Rapid 8-page-per-minute (approximately 333-characters per-second) print speed
- Typographic-quality 300-by-300-dots-per-inch character formation with even density and accurate alignment
- 250-sheet input and output paper cassettes accept standard 16–24 lb paper (and transparencies) in 8.5-by-11-inch and European (A4) sizes
- Automatic paging sequencing
- 16 resident fonts in two typefaces, including ASCII, multinational, and technical character sets
- Prints in both portrait and landscape modes
- Accepts precoded ROM font cartridges or programmable RAM cartridges
- Font information may be downline-loaded from host systems
- Built-in LA100 and LQP02 compatibility modes
- Supported by most major Digital operating systems and applications software
- Compact size: 15 inches high by 21 inches wide by 23.5 inches deep
- Quiet operation (under 54 decibels)
- Low cost-per-user; simple user-performed maintenance
- Built-in self-diagnostics and status indicators

Ordering Information

Please refer to the Printer Selection Chart in this chapter for ordering information. The LN03 Laser Printer includes two toner cartridges, one OPC cartridge, ac power cord, one toner collection bottle, one package (250 sheets) of paper, and documentation.

Font Cartridges

For LN03 and LN03 PLUS only.

LN03X-CS	Letter Gothic: 10-point normal; 10-point bold; 14-point normal; and U.S. legal characters
LN03X-CM	OCR-A/OCR-B: 10 point, 10 pitch
LN03X-CP	English 116 Embassy: (Script Text)
LN03X-IC	LN03 PLUS ISO/PC Cartridge (for use with the LN03 PLUS printer only)
LN03X-CT	U.S. legal: 10-point Courier; 10-point Courier italics; 10-point Elite; 10-point Elite italics; 10- and 14-point Gothic; 10- and 14-point symbols; Large Gothic
LN03X-CZ	CG Triumvirate Large: 24-point
LN03X-CW	CG Times Presentation: 18-point normal; 18-point bold; 14-point normal
LN03X-CX	CG Times Large: 24-point
LN03X-CL	ITC Souvenir: 10-point normal; 10-point bold; 10-point italics; 12-point normal; 12-point bold; 8-point normal
LN03X-CJ	CG Triumvirate Presentation: 18-point normal; 18-point bold; 14-point normal
LN03X-CY	CG Triumvirate: 10-point normal; 10-point italics; 8-point normal; 12-point normal; 12-point bold
LN03X-CB	CG Times: 10-point normal; 10-point bold; 10-point italics; 8-point normal; 12-point normal; 12-point bold
LN03X-DA	VT100/200 screen-extended Courier font

Accessories and Supplies

LN03X-CR	RAM cartridge
LN03-AD	User maintenance kit
LN01X-AB	Cutsheet paper (5000 sheets, 8.5 by 11 in)
LN03X-AJ	Transparencies (50 sheets, 8.5 by 11 in)
LN03X-AC	Toner cartridge kit
LN03X-AE	LN03 mobile cabinet stand
LN03S-UA	LN03 to LN03 PLUS upgrade kit
LN03R-UA	LN03 to ScriptPrinter conversion kit